PHY 1331. SPRING/SUMMER 2020
Dr. Celebi

Assignment #1

1. a) $v_f = v_i + ax$

Left side : $[v_f] = \frac{L}{T}$

Right side: $[v_i]+[a][x] = \frac{L}{T} + \left(\frac{L}{T^2}\right)(L)$

$= \frac{L}{T} + \frac{L^2}{T^2}$

$= \frac{L}{T} + \left(\frac{L}{T}\right)^2$

Because the two terms on the right side have different dimensions they cannot be added meaning that the left side and the right side have different dimensions. Therefore, the equation $v_f = v_i + ax$ is dimensionally incorrect

LS $\neq$ RS

b) $y = (2m)\cos(kx)$ where $k = 2m^{-1}$

Left side : $[y] = L$

Right Side : ① $[2m] = L$

② $[k][x] = [L^{-1}][L] = [L^0]$

③ $[\cos(kx)] = \left[\frac{\text{adjacent}}{\text{hypotenuse}}\right] = \frac{L}{L} = L^0$

④ $[(2m)\cos(kx)] = L$

$\therefore$ LS = RS

Because the dimensions on both the Left side and right side are the same, therefore the equation $y = (2m)\cos(kx)$ is dimensionally correct

2. Given: $r = 6.50 \text{ cm} = 6.50 \times 10^{-2} \text{ m}$

① uncertainty in $r = \pm 0.2 \text{ cm} = \pm 0.2 \times 10^{-2} \text{ m}$

② $m = 1.85 \pm 2 \times 10^{-2} \text{ Kg} \longrightarrow \frac{2 \times 10^{-2}}{1.85} \times 100$

uncertainty in $m = \pm 0.02 \text{ Kg}$

$= 1.08\%$

Know: volume of sphere: $V = \frac{4}{3} \pi r^3$

$\rho = \frac{m}{V}$

$$V = \frac{4}{3} \pi \left(6.50 \times 10^{-2} \text{ m} \pm 2 \times 10^{-3}\right)^3 \longrightarrow \frac{2 \times 10^{-3}}{6.50 \times 10^{-2}} \times 100$$

$V = 1.15 \times 10^{-3} \text{ m}^3 \pm 9.3\%$

$= (3.1\%)^3$

$= 9.3\%$

$$\rho = \frac{1.85 \pm 1.08\%}{1.15 \times 10^{-3} \pm 9.3\%}$$

$\rho = 1.16 \times 10^3 \pm 10.38\% \longrightarrow \frac{(10.38\%)(1.16 \times 10^3)}{100}$

$\rho = (1.16 \times 10^3 \pm 167) \text{ Kg/m}^3$

$= 167 \text{ Kg/m}^3$

∴ the density of the sphere

is $(1.16 \times 10^3 \pm 167) \text{ Kg/m}^3$

3. a) $\vec{R} = \vec{A} + \vec{B}$

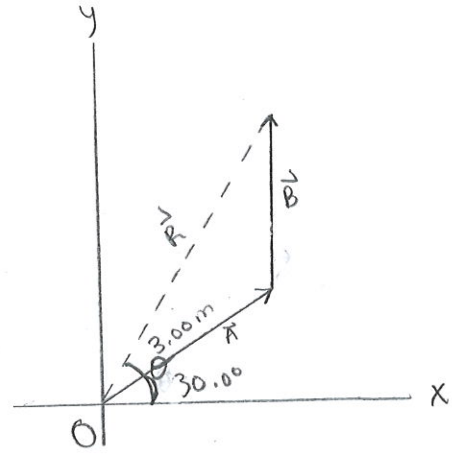
$= A_x\hat{i} + A_y\hat{j} + B_y\hat{j}$

$= A_x\hat{i} + (A_y + B_y)\hat{j}$

$= \frac{3\sqrt{3}}{2}\hat{i} + \left(\frac{9}{2}\right)\hat{j}$

$|\vec{R}| = \sqrt{\left(\frac{3\sqrt{3}}{2}\right)^2 + \left(\frac{9}{2}\right)^2}$

$|\vec{R}| = 5.20\text{m}$



$\theta = \tan^{-1}\left(\frac{9}{2} \div \frac{3\sqrt{3}}{2}\right)$

$\theta = \tan^{-1}\left(\frac{3}{\sqrt{3}}\right)$

$\theta = 60.0°$

b) $\vec{R} = \vec{A} - \vec{B}$

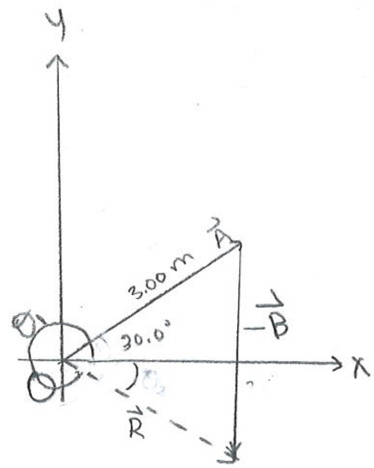
$= A_x\hat{i} + A_y\hat{j} - B_y\hat{j}$

$= A_x\hat{i} + (A_y - B_y)\hat{j}$

$= \frac{3\sqrt{3}}{2}\hat{i} + \left(-\frac{3}{2}\right)\hat{j}$

$|\vec{R}| = \sqrt{\left(\frac{3\sqrt{3}}{2}\right)^2 + \left(-\frac{3}{2}\right)^2}$

$|\vec{R}| = 3.00 \text{ m}$



$\theta_2 = \tan^{-1}\left(-\frac{3}{2} \div \frac{3\sqrt{3}}{2}\right)$

$\theta_2 = \tan^{-1}\left(\frac{1}{\sqrt{3}}\right)$

$\theta_2 = 30.0°$ clockwise

$\theta_1 = 330°$ counter clockwise

c) $\vec{R} = \vec{B} - \vec{A}$

$= B_y\hat{j} - (A_x\hat{i} + A_y\hat{j})$

$= B_y\hat{j} - A_y\hat{j} - A_x\hat{i}$

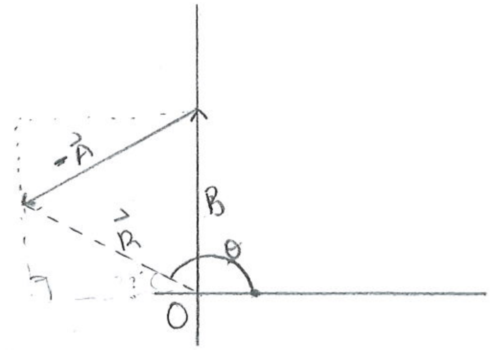
$= (B_y - A_y)\hat{j} - A_x\hat{i}$

$= \left(3.00 - \frac{3}{2}\right)\hat{j} - \frac{3\sqrt{3}}{2}\hat{i}$

$= -\frac{3\sqrt{3}}{2}\hat{i} + \frac{3}{2}\hat{j}$

$|\vec{R}| = \sqrt{\left(-\frac{3\sqrt{3}}{2}\right)^2 + \left(\frac{3}{2}\right)^2}$

$= 3.00 \text{ m}$



$\theta = \tan^{-1}\left(\frac{3}{2} \div -\frac{3\sqrt{3}}{2}\right)$

$\theta = 30°$

$180° - \theta = 150°$

d) $\vec{R} = \vec{A} - 2\vec{B}$

$= A_x\hat{i} + A_y\hat{j} - 2B_y\hat{j}$

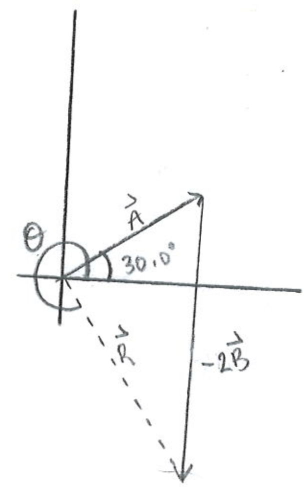
$= A_x\hat{i} + (A_y - 2B_y)\hat{j}$

$= \frac{3\sqrt{3}}{2}\hat{i} + \left(\frac{3}{2} - 6.00\right)\hat{j}$

$= \frac{3\sqrt{3}}{2}\hat{i} \left(-\frac{9}{2}\right)\hat{j}$

$|\vec{R}| = \sqrt{\left(\frac{3\sqrt{3}}{2}\right)^2 + \left(-\frac{9}{2}\right)^2}$

$|\vec{R}| = 5.20 \text{ m}$



$\theta = \tan^{-1}\left(-\frac{9}{2} \div \frac{3\sqrt{3}}{2}\right)$

$\theta = 60°$

$360° - 60 = 300°$

$\therefore \theta = 300° \text{ CCW}$

4. a) $x(t) = (3.00t^2 - 2.00t + 3.00)\,m$

Average speed between $t_1 = 2.00\,s$
$t_2 = 3.00\,s$

$x_1(2.00) = [3.00(2.00)^2 - 2.00(2.00) + 3.00]\,m$

$= 11\,m$

$x_2(3.00) = [3.00(3.00)^2 - 2.00(3.00) + 3.00]\,m$

$= 24\,m$

$$v_{avg} = \frac{x_2 - x_1}{t_2 - t_1}$$

$$= \frac{24m - 11m}{3s - 2s}$$

$= 13\,m/s$

$\therefore$ The average speed between $t = 2.00s$ and $t = 3.00s$ is $13.0\,m/s$

b) instantaneous speed at $t = 2.00s$
$t = 3.00s$

$$v_x = \frac{dx}{dt}$$

$$v_x = \frac{d}{dt}(3t^2 - 2t + 3)\,m$$

$v_x = 6t - 2$

① At $t = 2.00s$

$v_x = 6(2.00) - 2$

$= 10\,m/s$

② At $t = 3.00s$

$v_x = 6(3.00) - 2$

$= 16\,m/s$

$\therefore$ the instantaneous speed at $t = 2.00s$ is $10\,m/s$ and $t = 3.00s$ is $16\,m/s$

c) Average acceleration between $t = 2.00s$
$t = 3.00s$

① at $t_1 = 2.00s$

$v_1(2.00) = 6(2.00) - 2$
$= 10 \text{ m/s}$

② at $t_2 = 3.00s$

$v_2(3.00) = 6(3.00) - 2$
$= 16 \text{ m/s}$

③ $a_{avg} = \dfrac{v_2 - v_1}{t_2 - t_1}$

$= \dfrac{16 \text{ m/s} - 10 \text{ m/s}}{3s - 2s}$

$= 6 \text{ m/s}^2$

∴ The average acceleration between $t = 2.00s$ and $t = 3.00s$ is 6 m/s^2

d) instantaneous acceleration at $t = 2.00s$
$t = 3.00s$

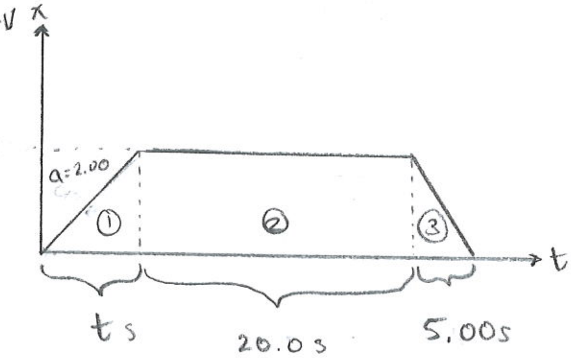
$a_x = \dfrac{dv}{dt}$

$= \dfrac{d}{dt}(6t - 2)$

$a_x = 6 \text{ m/s}^2$

∴ at $t = 2.00s$ and $t = 3.00s$ the acceleration remains constant

5. a) Given:



$t_{total} = t + 20.0s + 5.00s$

$a_x = 2.00\, m/s$

$V_f = 20.0 \qquad V_i = 0$

$$A_x = \frac{V_f - V_i}{t_f - t_i}$$

$$2.00 = \frac{20.0 - 0}{t - 0}$$

$$2.00 = \frac{20.0}{t}$$

$2.00t = 20.0$

$t = 10.0\, s$

$t_{total} = t + 20.0s + 5.00s$

$= 10.0s + 20.0s + 5.00s$

$= 35.0\, s$

∴ the truck is in motion for 35.0 s

b) $X_{f1} = X_i + V_{xi}t + \frac{1}{2}a_x t^2$

$= 0 + 0 + \frac{1}{2}(2.00)(10)^2$

$= 100\, m$

$X_{f2} = (V_x)(t)$

$= (20.0)(20.0)$

$= 400\, m$

$$a_x = \frac{V_2 - V_1}{t_2 - t_1}$$

$$= \frac{0 - 20.0}{35.0 - 30.0}$$

$= -4.00\, m/s^2$

$X_{i3} = X_i + V_{xi}t + \frac{1}{2}a_x t^2$

$= 0 + (20.0)(5.00) + \frac{1}{2}(-4.00)(5.00)^2$

$= 100 - 50.0$

$= 50\, m$

$\Delta X = 100 + 400 + 50.0$

$= 550\, m$

$$V_{av} = \frac{\Delta X}{\Delta t}$$

$$= \frac{550m}{35.0\, s}$$

$= 15.7\, m/s$

∴ The average velocity of the truck for the motion described is 15.7 m/s

2. a) $X_f = X_i + V_{xi}t + \frac{1}{2}a_x t^2$

Solving for initial velocity:

$$V_{xi} = \frac{X_f - X_i - \frac{1}{2}a_x t^2}{t}$$

$$V_{xi} = \frac{4.00 - \left(\frac{1}{2}\right)(-9.8)(1.5)^2}{1.5}$$

$$V_{xi} = 10.0 m/s$$

∴ the initial velocity the keys were thrown was at 10.0 m/s

b) $V_f = V_{xi} + (a_x)(t)$

$= 10.0 + (-9.8)(1.5)$

$= -4.68 m/s$

∴ the velocity of the keys just before they were caught was -4.86 m/s