F17-Concordia-Mech-A1

September 22, 2017 5:00 PM

Phys 204/03
Assignment 1
solutions

① To determine what quantity ρ represents, we should use Dimensional analysis:

$$R = \frac{1}{2} \rho A D V^2$$

R: $kg \frac{m}{s^2} \rightarrow MLT^{-2}$

A: $m^2 \longrightarrow L^2$

V: $\frac{m}{s} \rightarrow LT^{-1}$

$$\rho = \frac{2R}{ADV^2} \rightarrow [\rho] = \frac{MLT^{-2}}{L^2.(LT^{-1})^2}$$

$$\rightarrow [\rho] = \frac{M\cancel{LT^{-2}}}{L^2.\cancel{L^2T^{-2}}} = \frac{M}{L^3} \rightarrow \frac{kg}{m^3}$$

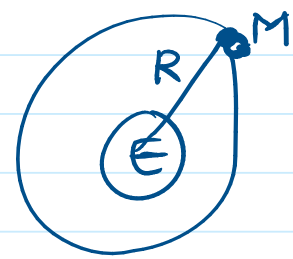
which is the unit of Density.

(2) $T = 28 \text{ days} = 28 \times 24 \times 60 \times 60 \text{ sec} = 2.42 \times 10^6 \text{ s}$

$R = 385000 \text{ km} = 3.85 \times 10^8 \text{ m}$

a) $\vec{V}_{avg.} = \dfrac{\vec{\Delta x}}{\Delta t} = 0$ in one full revolution, the moon returns to its original position $\longrightarrow \Delta \vec{x} = 0$

b) $V_{avg.} = \dfrac{d}{\Delta t}$

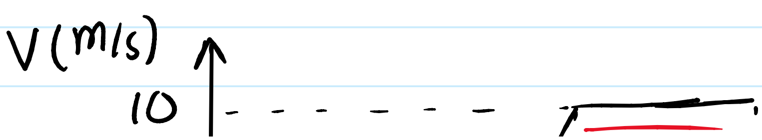


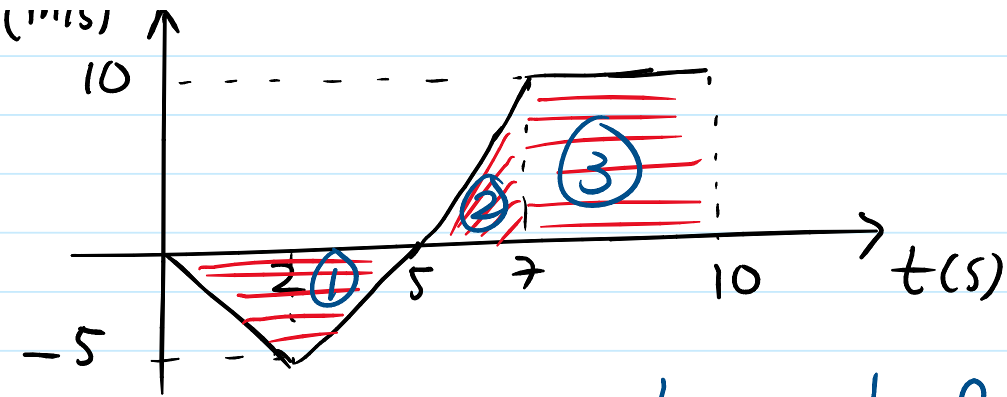
$d = 2\pi R = 2(3.14)(3.85 \times 10^8) \Rightarrow$

$\boxed{d = 2.42 \times 10^9 \text{ m}}$

$V_{avg.} = \dfrac{2.42 \times 10^9}{2.42 \times 10^6} = \boxed{1 \times 10^3 \dfrac{m}{s}} = \boxed{1 \dfrac{km}{s}}$

(3)





a) To find total displacement, we should calculate the are under the graph, respecting ± signs:

$$A_1 = \frac{(-5)(5)}{2} = -\frac{25}{2}m = \vec{\Delta x_1}$$

$$A_2 = \frac{(10)(7-5)}{2} = 10\ m = \vec{\Delta x_2}$$

$$A_3 = (10)(10-7) = 30\ m = \vec{\Delta x_3}$$

$$\vec{\Delta x}_{tot} = \vec{\Delta x_1} + \vec{\Delta x_2} + \vec{\Delta x_3} = -12.5 + 10 + 30 = \boxed{27.5m}$$

b) $$d_{tot} = |\vec{\Delta x_1}| + |\vec{\Delta x_2}| + |\vec{\Delta x_3}| = 12.5 + 10 + 30 = \boxed{52.5m}$$

c) $a_{avg} = \frac{V_f - V_i}{\Delta t} = \frac{(10)-(-5)}{10-2} = \frac{15}{8} = \boxed{1.875 \frac{m}{s^2}}$

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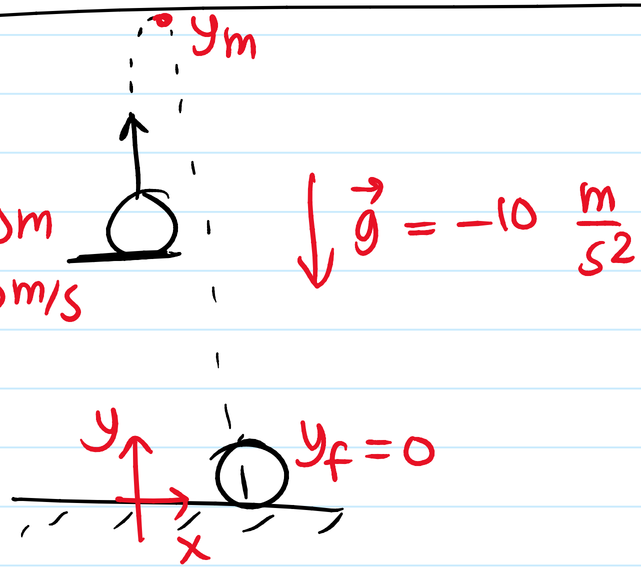


a) At max height: $V_m = 0$

Using time-independent equation:

$$\cancel{V_m^2} - V_i^2 = -2g(y_m - y_i)$$

0

$$y_m - y_i = \frac{-V_i^2}{-2g} \rightarrow y_m = y_i + \frac{V_i^2}{2g}$$

$$-2g \qquad \qquad 2g$$

$$y_m = 30 + \frac{(10)^2}{2(10)}$$

$$\boxed{y_m = 30 + 5 = 35\,m}$$

b) to find Δt:

$$y_f = y_i + (v_i)\Delta t - \frac{1}{2} g \Delta t^2$$

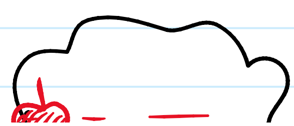
$$0 = 30 + 10\Delta t - 5\Delta t^2$$

$$\rightarrow \Delta t^2 - 2\Delta t - 6 = 0$$

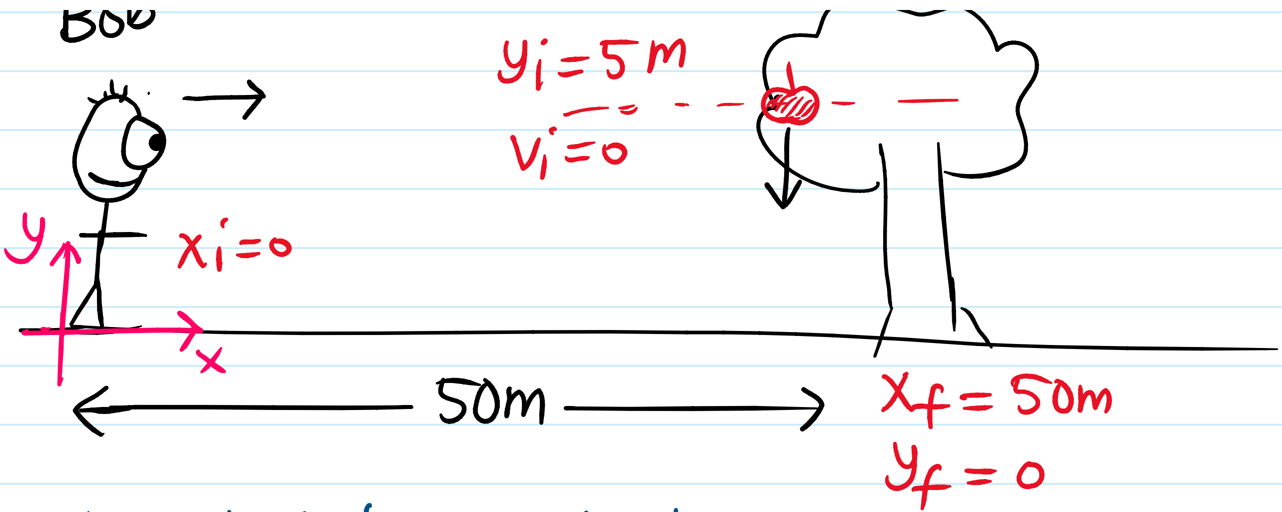
$$\rightarrow \begin{cases} \cancel{\Delta t_1 = -1.65\,s} \rightarrow \text{not acceptable} \\ \boxed{\Delta t_2 = 3.65\,s} \end{cases}$$

5 Bob

$y_i = 5m$



(5)



The time it takes Bob to reach the apple should be the same as the time it takes the apple to reach the ground:

apple:

$$\cancel{y_f}^{\,0} = y_i + \cancel{v_i}^{\,0}\,\Delta t - \tfrac{1}{2} g \Delta t^2$$

$$0 = 5 - 5\Delta t^2$$

$$\rightarrow \boxed{\Delta t = 1\,s}$$

Bob

$$x_f = x_i + v_B \Delta t$$

$$v_B = \frac{x_f - x_i}{\Delta t} = \frac{50-0}{1}$$

Super Bob! $\leftarrow$ $\boxed{v_B = 50\ \frac{m}{s}}$

Super Bob! $\leftarrow$ $v_B = 30\ \frac{m}{s}$

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6 $\vec{A} = (2\hat{i} - \hat{j} + 3\hat{k})\,m$

$\vec{B} = (\hat{i} + \hat{j} - \hat{k})\,m$

$\vec{A} \pm \vec{B} = (A_x \pm B_x)\,\hat{i} + (A_y \pm B_y)\,\hat{j} + (A_z - B_z)\,\hat{k}$

$\vec{A} - \vec{B} = (2-1)\,\hat{i} + (-1-1)\,\hat{j} + (3-(-1))\,\hat{k}$

$\boxed{\vec{A} - \vec{B} = \hat{i} - 2\hat{j} + 4\hat{k}} \rightarrow \boxed{|\vec{A} - \vec{B}| = \sqrt{(1)^2 + (-2)^2 + (4)^2} = \sqrt{21}}$

$\vec{A} + \vec{B} = (2+1)\,\hat{i} + (-1+1)\,\hat{j} + (3+(-1))\,\hat{k}$

$\boxed{\vec{A} + \vec{B} = 3\hat{i} + 2\hat{k}} \rightarrow \boxed{|\vec{A} + \vec{B}| = \sqrt{3^2 + 2^2} = \sqrt{13}}$

$$\frac{|\vec{A}-\vec{B}|}{|\vec{A}+\vec{B}|} = \boxed{\frac{\sqrt{21}}{\sqrt{13}} = \sqrt{\frac{21}{13}}}$$

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7 $(V_i)_1 = 50\ \frac{km}{h}$ $\qquad$ $(V_i)_2 = 70\ \frac{km}{h}$

$V_f = 0$ $\qquad$ $V_f = 0$

$d_1 = 20m$ $\qquad$ $d_2 = ?$

Assuming same deceleration:

Using $\cancel{V_f^2}^{\,0} - (V_i^2)_1 = 2a\,d_1$

$\rightarrow a = \frac{-(V_i)_1^2}{2d_1}$

$\cancel{(V_f)^2}^{\,0} - (V_i)_2^2 = 2a\,d_2$

$$d_2 = \frac{-(v_i')_2^2}{2a} = \frac{-(v_i')_2^2}{\cancel{2}\left[-(v_i')_1^2 / \cancel{2} d_1\right]}$$

$$d_2 = \left[\frac{(v_i')_2}{(v_i')_1}\right]^2 d_1 = \left[\left(\frac{70}{50}\right)^2\right](20\,m)$$

$$\boxed{d_2 = \left(\frac{49}{25}\right)(20) = 39.2\ m}$$