# PHY 105 Test 1 September 30, 2005 Solutions

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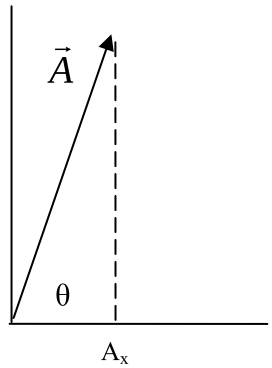
1. Letting $A = \left|\vec{A}\right|$ ....




$$A_x = \tfrac{1}{4}A$$
$$A\cos\theta = \tfrac{1}{4}A$$
$$\theta = \cos^{-1}\left(\tfrac{1}{4}\right)$$
$$\theta = 75.52° \text{ (1.318 rad)}$$

2. Air time is calculated by setting y=0 into the projectile equation for y-motion: $y = y_0 + v_{0y}t - \frac{1}{2}gt^2$, where $v_{0y} = v_0 \sin\theta = 980\sin 30° = 490\,\frac{\text{m}}{\text{s}}$. Solving:

$$0 = 0 + v_{0y}t - \tfrac{1}{2}gt^2$$
$$0 = \left(v_{0y} - \tfrac{1}{2}gt\right)t$$
$$t_A = \frac{2v_{0y}}{g} \text{ or } t_A = 0$$
$$\text{taking the non-zero solution, } t_A = \frac{2(490)}{9.8} = 100\,\text{s}$$

The range is then $R = v_{0x}t_A = 980\left(\cos 30°\right)100 = 84{,}870\,\text{m}$

3. Because $LT = \left[L^2T^{-1}\right]^n\left[LT^2\right]^m$, $n$ and $m$ must satisfy

$$2n + m = 1$$
$$2m - n = 1$$

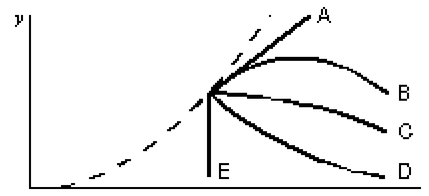
Therefore $n = \frac{1}{5}$; $m = \frac{4}{5}$

4. a) Because $v(t) = \dfrac{dx}{dt} = 16 - 9t^2$ m/s, $v(15) = 16 - 9\left(15^2\right) = -2009\,\text{m/s}$

b) $\bar{a} = \dfrac{\Delta v}{\Delta t} = \dfrac{v(30) - v(0)}{30 - 0} = \dfrac{\left[16 - 9\left(30^2\right)\right] - \left[16 - 9\left(0^2\right)\right]}{30} = -27\,\text{m/s}^2$

5. (e) is impossible because a constant velocity can only occur if there is NO acceleration

6. At the time the bolt breaks loose, it has an upward velocity. The bolt then is in free-fall with an initial y-velocity. This is displayed by curve B




7. Given that $a_c = \frac{v^2}{R}$, $25g = \frac{v^2}{R}$, and $v = 5\sqrt{Rg}$. In this problem, R= 1 m, and therefore $v$ = 15.65 m/s

8. This is a free-fall problem with $y_0$= 1.5 m, y = 2.0 m, and t = 2 s. Substituting these values into $y = y_0 + v_0 t - \frac{1}{2} g t^2$ and solving for velocity yields $v_0$ = 10.05 m/s

9. If North is in the y-direction, then $\vec{\mathbf{v}}_1 = 500\hat{\mathbf{j}}$ and $\vec{\mathbf{v}}_2 = -500\hat{\mathbf{j}}$. The average acceleration is therefore (with $\Delta t = 40\,\mathrm{s}$)

$$\begin{aligned}
\vec{\mathbf{a}}_{\mathbf{avg}} &= \frac{\vec{\mathbf{v}}_2 - \vec{\mathbf{v}}_1}{\Delta t} \\
&= \frac{\left(-500\hat{\mathbf{j}}\right) - \left(-500\hat{\mathbf{j}}\right)}{40} \\
&= -25\hat{\mathbf{j}}\frac{\mathrm{km}}{\mathrm{hr}\times\mathrm{s}} \\
&= -6.94\,\hat{\mathbf{j}}\ \ \mathrm{m/s^2}
\end{aligned}$$