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HW5

4. $x(t)=60e^{-4.8t}\sin(16t)$

$v(t)=\frac{dx}{dt}=(60e^{-4.8t})(16\cos(16t))+(60\sin(16t))(-4.8te^{-4.8t})$

$=960e^{-4.8t}\cos(16t)-288e^{-4.8t}\sin(16t)$

$a(t)=\frac{dv}{dt}=e^{-4.8t}[-13977.6\sin(16t)-9216\cos(16t)]$

(a) At $t=0$

$x(0)=0$ $v(0)=960\,mm/s\rightarrow$ $a(0)=-9216\,mm/s^2\leftarrow$

(b) At $t=0.3$

$x(0.3)=-14.16mm\leftarrow$ $v(0.3)=87.867\,mm/s\rightarrow$ $a(0.3)=3137.67\,mm/s^2\rightarrow$

6. (a) $v(t)=\frac{dx}{dt}=3t^2-18t+24$

$3t^2-18t+24=0\Rightarrow t_1=4$ $t_2=2$

(b) $a(t)=\frac{dv}{dt}=6t-18$

$6t-18=0\Rightarrow t=3$

$x_3=t^3-9t^2+24t-8=3^3-9\cdot3^2+24\cdot3-8=10in$

$x_0=-8in$ $x_2=12in$

$l=8+12+(12-10)=22\,in$

9. (a) $2ax=v^2\Rightarrow v_0=77.5\,ft/s\rightarrow$

(b) $\frac{1}{2}at^2=x\Rightarrow t=7.75s$

28. $v=\frac{dx}{dt}=7.5(1-0.04x)^{0.3}$

$\Rightarrow\int_0^x(1-0.04x)^{-0.3}dx=\int_0^t 7.5\,dt$

$\Rightarrow 0.4t=1-(1-0.04x)^{0.7}$

(a) At $t=1h$

$-0.7=-(1-0.04x)^{0.7}\Rightarrow x=7.477\,km$

(b) $a=v\frac{dv}{dx}=0.675(1-0.04x)^{-0.4}$

At $t=0\rightarrow x=0$

$a=2.75\times10^{-4}\,ft/s^2$

(c) At $x=6\,mi$

$t=0.8322\,hr=49.93\,min$

48. (a) $\frac{1}{2}a_E5^2=30\Rightarrow a_E=2.4\,ft/s^2$

$a_E=-a_W=-2.4\,ft/s^2$

$a_C=-2a_E=4.8\,ft/s^2$

(b) $v_E=-2.4\times5=-12\,ft/s$

51. (a) $v_A=\frac{2}{3}v_B=200\,in/s$

(b) $v_C=2v_B=600\,mm/s$

(c) $\because x_C-x_A+x_D-x_A=C$

$\therefore v_C+v_D-2v_A=0$

$\Rightarrow v_D=2v_A-v_C=400-600=-200mm/s$

(d) $v_{C/A}=v_C-v_A=200\,mm/s$

56. (a) $\begin{cases}y_A+2y_B-y_D=C\Rightarrow y_A+2y_B+y_C=C\\ y_C+2y_D=C\end{cases}$

$0-2v_B+v_C=0$

$6t+0+a_C=0$ $\Rightarrow v_C=6-6t$

$v_C=0\Rightarrow t=1s$

(b) $6\times1-\frac{1}{2}\times6\times1^2=3\,in$

108. $v_x=v_0\cos5^\circ$ $t=\frac{x}{v_0\cos5^\circ}$

$y=h-v_0\sin5^\circ t-\frac{1}{2}gt^2$

$\Rightarrow y=2.5-v_0\sin5^\circ\frac{x}{v_0\cos5^\circ}-\frac{1}{2}g\left(\frac{x}{v_0\cos5^\circ}\right)^2$

$\Rightarrow y=2.5-x\tan5^\circ-\frac{4.9x^2}{v_0^2\cos^25^\circ}$

$\Rightarrow v_0^2=\frac{4.9x^2}{(2.5-x\tan5^\circ-y)\cos^25^\circ}$

$\because y=0$, $12.2<x<18.6$

$\therefore 14.36\,m/s<v_0<20.354\,m/s$

140. (a) $V = 100 \cdot \frac{1000^2}{3600} = 27.778\ m/s$

$d_c = 150 \cdot \frac{\pi}{2} + 100 = 335.4\ m$

$a_t = \frac{V^2}{2d_c} = 1.15\ m/s^2$

$d_3 = 150 \cdot \frac{\pi}{2} = 75\pi\ m$

$V_f = \sqrt{2a_t d_3} = 23.79\ m/s$

(b) $V = V_0 + a_t t = 23\ m/s$

$a_n = \frac{V^2}{\rho} = 3.527\ m/s^2$

$|a| = \sqrt{a_n^2 + a_t^2} = 3.709\ m/s^2$

142. $a_A = 8\ m/s^2$ $r = 300\ m$ $a_{B/A} = 3\ m/s^2 \downarrow$

(a) $\vec{V}_{B/A} = \vec{V}_B - \vec{V}_A = \sqrt{V_A^2 + V_B^2 - 2V_A V_B \cos\theta} = 501.1\ km/h$

$V_x' = 540\cos 60^\circ - 45 = -180\ km/h \leftarrow$

$V_y' = 540\sin 60^\circ = 467.1\ km/h \downarrow$

(b) $a_{B/A} = \frac{V_{B/A}^2}{\rho} = \frac{(540 \times \frac{1000}{3600})^2}{300} = 75\ m/s^2$

$a_x' = 3 \times \frac{1}{2} + 75 \times \frac{\sqrt{3}}{2} - 8 = 58.375\ m/s^2 \leftarrow$

$a_y' = 75 \times \frac{1}{2} - 3 \times \frac{\sqrt{3}}{2} = 34.9\ m/s^2 \downarrow$