PHY 2048
Test I – 13 Feb 2017

Solutions
— V.I —

(1) (a) Choose downward as positive direction

$d_1 = 130\ m \rightarrow d_1 = \frac{1}{2} g t_1^2 \Rightarrow \boxed{t_1 = \sqrt{2d_1/g} = 5.15\ s}$

$\rightarrow \boxed{v_1 = g t_1 = 50.5\ m/s}$

(b) Now $a_2 = -7.25\ m/s$ and $v_2 = 6.50\ m/s$

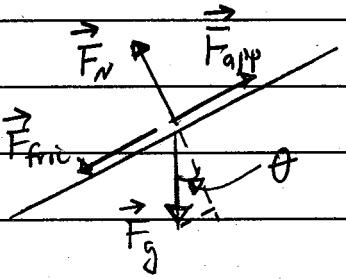
$\rightarrow \Delta v = v_2 - v_1 = -43.98\ m/s \rightarrow \boxed{t_2 = \Delta v / a_2 = 6.07\ s}$

(c) $d_2 = v_1 t_2 + \frac{1}{2} a_2 t_2^2 \Rightarrow \boxed{d_2 = 173\ m}$

(d) $t_{total} = 60.0\ s \Rightarrow t_3 = t_{total} - t_1 - t_2 = 48.78\ s$

$\rightarrow d_3 = v_2 t_3 = 317\ m \Rightarrow \boxed{h = d_1 + d_2 + d_3 = 620\ m}$

(2) (a)



$m = 5.00\ kg$ and $\theta = 36.9°$

$\rightarrow F_N = F_g \cos\theta = mg\cos\theta$

$\rightarrow \boxed{F_N = 39.2\ N}$

(b) Forces balance if no motion $\Rightarrow F_s = F_{app} - F_g \sin\theta$

$F_{app} = 35.0\ N \rightarrow \boxed{F_s = 5.58\ N}$

(c) $F_s^{max} = \mu_s F_N = 11.76\ N \rightarrow F_{app}^{max} = F_s^{max} + F_g \sin\theta$

$\rightarrow \boxed{F_{app}^{max} = 41.2\ N}$

(d) Now $ma = F'_{app} - F_K - F_g \sin\theta$

$F'_{app} = 45.0\ N$ and $F_K = \mu_K F_N = 7.84\ N \rightarrow ma = 7.74\ N$

$\rightarrow \boxed{a = 1.55\ m/s^2}$

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Solutions

(3) (a) $f = 4.0$ rev/sec $\rightarrow$ $\boxed{T = 1/f = 0.250\ s}$ 2/

(b) $r = 0.750$ m $\rightarrow$ $T = 2\pi r/v \Rightarrow \boxed{v = 2\pi r/T = 18.8\ m/s}$ 5/

(c) centripetal acceleration $\rightarrow a_c = v^2/r = 473.7\ m/s^2$ 5/

$m = 0.250$ kg $\rightarrow \boxed{T = ma_c = 118\ N}$

(d) double tension $\rightarrow$ doubles a_c

6/ $$a_c = \frac{v^2}{r} = \frac{1}{r}\left(\frac{2\pi r}{T}\right)^2 = \frac{4\pi^2}{T^2} r$$

$\rightarrow$ same T $\Rightarrow$ $\boxed{r \text{ must double}}$

(4) (a) $v_0 = 75.0$ m/s, $\theta = 30^\circ \Rightarrow v_{0y} = v_0 \sin\theta = 37.5$ m/s 5/

At highest pt, $v_y = 0 \Rightarrow -v_{0y}^2 = -2gh \Rightarrow h = v_{0y}^2/2g$

$\rightarrow \boxed{h = 71.7\ m}$

(b) Since $\Delta y = 0$, d is given by the range formula. 5/

$\rightarrow \boxed{d = v_0^2 \sin 2\theta/g = 497\ m}$

$\Delta y = 0$ at pt B $\Rightarrow \boxed{v_B = v_0 = 75.0\ m/s}$

(c) $\Delta x = d + D = 647$ m and $\Delta x = v_{ox}\, t_{air}$ 4/

$v_{ox} = v_0 \cos\theta = 64.95$ m/s $\rightarrow \boxed{t_{air} = 9.96\ s}$

(d) $v_{Fx} = v_{ox} = 64.95$ m/s, $v_{Fy} = v_{oy} - g\, t_{air} = -60.13$ m/s 6/

$\rightarrow \boxed{v_F = (v_{Fx}^2 + v_{Fy}^2)^{1/2} = 88.5\ m/s}$

$\tan\theta_F = \frac{v_{Fy}}{v_{Fx}} = -0.9258 \rightarrow \boxed{\theta_F = 42.8^\circ \text{ below horiz.}}$