Exam #1 Solutions

Phys 131
Spring 2001

I. Multiple Choice

1. D

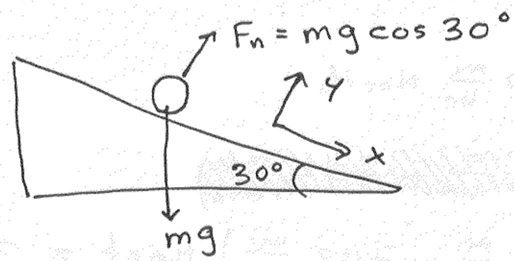
2. C

3. D

4. A

5. B, C, D ← any of these

I. (a)



$a_x = g\sin 30° = 4.9\ \frac{m}{s^2}$

(b)

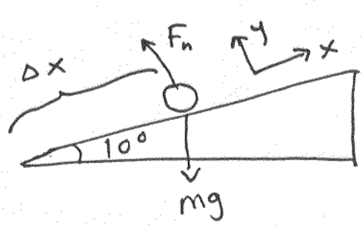
$$v_x^2 - \underset{\overset{\|}{0}}{v_{x_0}^2} = 2a_x(x - x_0)$$

$$v_x^2 - 0 = 2(g\sin 30°)(1\,m)$$

$$\rightarrow v_x = 3.1\ \frac{m}{s}$$

Since there is no y-component to $\vec{v}_1$ then $|\vec{v}| = 3.1\ \frac{m}{s}$

(c)



$$\sum F_x = -mg\sin 10° = ma_x$$

$$\rightarrow a_x = -g\sin 10° = -1.7\ \frac{m}{s^2}$$

(continued)

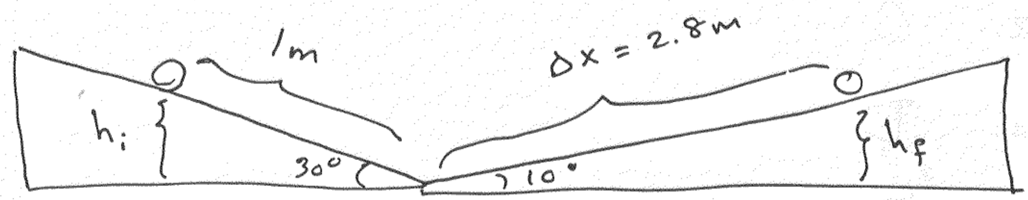
I. (c) continued

Then $v_x^2 - v_{x_0}^2 = 2a_x(x - x_0)$

$$\underset{\|}{0} - \underset{\|}{\left(3.1\tfrac{m}{s}\right)^2} = 2\left(-1.7\tfrac{m}{s^2}\right)\Delta x$$

So, $\Delta x = 2.8\ m$

(d)



Initial height $= h_i = (1m)\sin 30° = 0.5\ m$

Final height $= h_f = (2.8m)\sin 10° = 0.5\ m$

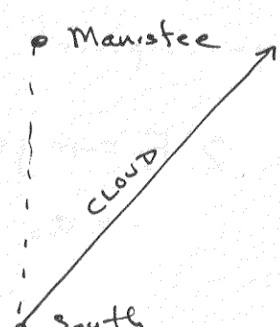
II. (a) $\vec{V}_{cloud,SB} = 50.0\ \frac{mi}{hr}$ North

$\vec{V}_{SB,man} = \left(774\ \frac{mi}{hr} - 743\ \frac{mi}{hr}\right)$ East $= 31.\ \frac{mi}{hr}$ East

So, $\vec{V}_{cloud,man} = \vec{V}_{cloud,SB} + \vec{V}_{SB,man}$

$= 50\ \frac{mi}{hr}$ North $+ 31\ \frac{mi}{hr}$ East

So trajectory takes cloud to east of Manistee:

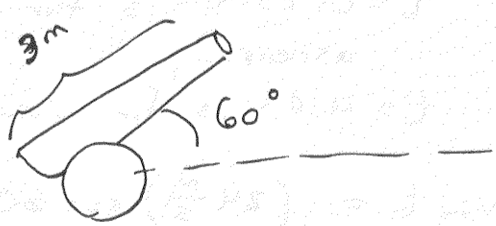


I. (b) Since the cloud travels north at $50 \frac{mi}{hr}$, it will be even with Manistee at a time $t = \frac{205 \text{ miles}}{50 \text{ m/hr}} = 4.1 \text{ hr}$ after leaving South Bend. In 4.1 hours, it travels a distance to the east of $(31 \frac{mi}{hr})(4.1 \text{ hr}) = 130$ miles.

(or 127 miles w/ one extra digit

So it will miss Manistee by 130 miles.

V.



While clown is in cannon, $F = 5000 \text{ N} = ma$

So, $a = \left(\frac{5000 \text{ N}}{50 \text{ kg}}\right) = 100 \frac{m}{s^2}$

His final velocity as he leaves the barrel is:

$$v^2 - v_0^2 = 2a\Delta x$$

$$\rightarrow v^2 - 0 = 2\left(100 \frac{m}{s^2}\right)(3 \text{ m})$$

$$\Rightarrow v = 24 \frac{m}{s}$$

How much time does he spend in the air?

$$\Delta y = v_{y0} t - \frac{1}{2} g t^2$$

where $v_{y0} = v \sin 60° = (24 \frac{m}{s}) \sin 60° = 21 \frac{m}{s}$

and $\Delta y = 5 \text{ m}$

(continued)

I. (continued)

So, $5\,m = (21\,\frac{m}{s})t - \frac{1}{2}(9.8\,\frac{m}{s^2})t^2$

Solve for t using quadratic formula:

$$t = \frac{-21 \pm \sqrt{(21)^2 - 4\cdot\frac{1}{2}(9.8)(5)}}{(-9.8)} \text{ seconds}$$

$$= \begin{cases} 0.25\,s \\ 4.0\,s \end{cases}$$

Two solutions! $t = 0.25\,s$ is for clown's ascension, $t = 4.0\,s$ is for clown's fall.

So, $t = 4.0\,s$, so $\Delta x = V_{0x} t = (24\,\frac{m}{s})\cos 60° \cdot (4.0s)$

$= 48\,m$

Thus, the platform should be placed 48 m from the end of the cannon.

I. (a) No. $F_g = mg = 9800\,N > F_{thrust} = 5000\,N$.

(b) $\sum F = F_{thrust} - F_g = 5000\,N - (1000\,kg)(1.5\,\frac{m}{s^2})$

$= 3500\,N = ma$

So $a = 3.5\,\frac{m}{s^2}$

(c) $\sum F = F_{thrust} - F_g - F_{bungee} = 3500\,N - kx^2$

Setting $\sum F = 0 = 3500\,N - (25\,\frac{N}{m^2})x^2$

So $x = 11.8\,m$