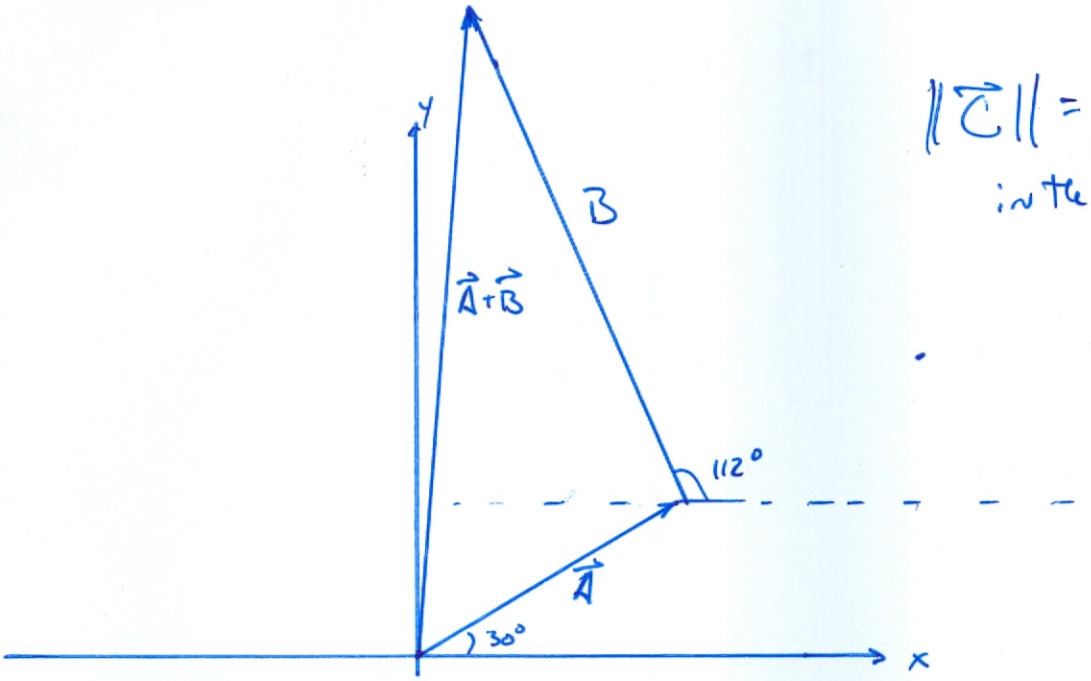
Sol$^{\underline{n}}$s for practice exam #2 phyics 151 Fall 2007

1) a) $\vec{A}$ is 4 cm @ 30°
$\vec{B}$ is 7cm @ 112°



$\|\vec{C}\| = 8.5$cm
in the direction 85° from x-axis

b) $$\vec{A} = 4\text{cm}\cos 30°\,\hat{i} + 4\text{cm}\sin 30°\,\hat{j}$$
$$+\ \vec{B} = 7\text{cm}\cos 112°\,\hat{i} + 7\text{cm}\sin 112°\,\hat{j}$$
$$\vec{C} = (4\text{cm}\cos 30° + 7\text{cm}\cos 112°)\,\hat{i} + (4\text{cm}\sin 30° + 7\text{cm}\sin 112°)\,\hat{j}$$
$$= 0.84\text{cm}\,\hat{i} + 8.49\text{cm}\,\hat{j}$$

c) $|\vec{C}| = \sqrt{C_x^2 + C_y^2} = 8.53$ cm

d) angle $= \operatorname{atan}\frac{C_y}{C_x} = 84.3°$

#2 a) If both balls leave the table at the same time gravity will accelerate both at the same rate and both will hit the ground at the same time.

b) B because there is an initial $+V_x$ and no accel.

c) H initially $V_y = 0$ constant negative accel.

d) F constant negative accel.

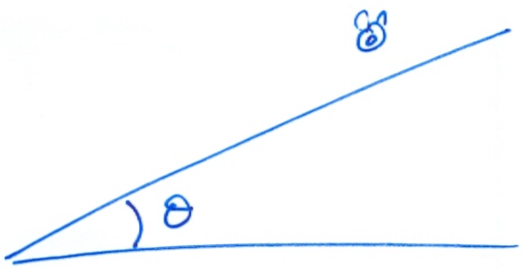
e) F gravity points in negative y direction

f) ~~[illegible]~~ F 〃

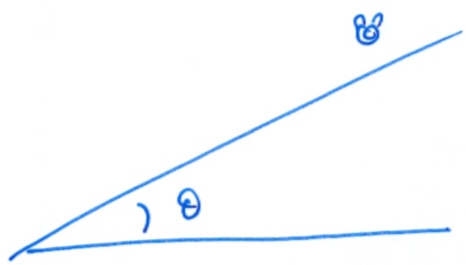
g) D Starts w/ and keep $V_x = 0$

h) F

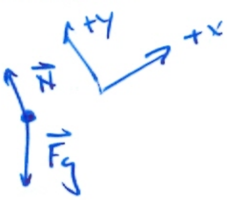
#3

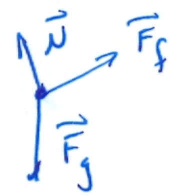


No friction



Friction





$$a_x = \sum \frac{F_x}{m} = \frac{-mg\sin\theta}{m} = -g\sin\theta$$

$$a_y = \sum \frac{F_y}{m} = \frac{N - mg\cos\theta}{m} = 0 \text{ by observation}$$

$$a_x = a = -g\sin\theta$$

$$a_x = \sum \frac{F_x}{m} = \frac{F_f - mg\sin\theta}{m}$$

$$a_y = \sum \frac{F_y}{m} = \frac{N - mg\cos\theta}{m} = 0 \text{ by inspection}$$

$$N = mg\cos\theta$$

$$a_x = a_f = \frac{F_f - mg\sin\theta}{m} = \cancel{\mu_k N - mg\sin\theta}$$

$$\cancel{[illegible]} - g\sin\theta$$

$$a_f = \frac{F_f - mg\sin\theta}{m}$$

$$= \frac{\mu_k N - mg\sin\theta}{m}$$

$$= \frac{\mu_k mg\cos\theta - mg\sin\theta}{m} = g(\mu_k\cos\theta - \sin\theta)$$

Now the time of descent can be related to the length of the ramp by

$$x = x_0 + v_{0x}t + \tfrac{1}{2}a_x t^2$$

with $v_{0x} = 0$ and $x_0 = 0$

$$x = \tfrac{1}{2}(a_x)t^2$$

for non friction

$$x = \tfrac{1}{2}at^2$$
$$= \tfrac{1}{2}at^2$$

for friction it takes twice as long

$$x = \tfrac{1}{2}a_f(2t)^2$$
$$= 2a_f t^2$$

since both ramps are the same length

$$\tfrac{1}{2}at^2 = 2a_f t^2$$

or

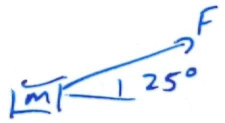
$$a = 4a_f$$

$$-g\sin\theta = 4g(\mu_k\cos\theta - \sin\theta)$$

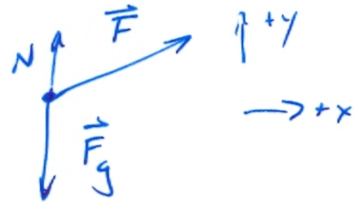
$$-\sin\theta + 4\sin\theta = 4\mu_k\cos\theta$$

$$\frac{3}{4}\frac{\sin\theta}{\cos\theta} = \frac{3}{4}\tan\theta = \mu_k$$

4



a) Free body diagram for block



$$a_x = \frac{\sum_i F_x}{m} = \frac{\|\vec{F}\| \cos 25^\circ}{m} = \frac{12\,N \cos 25^\circ}{5\,kg}$$
$$= 2.18\ m/s^2$$

b) The Normal force will vanish just before the block accelerates in the y-direction.

$$a_y = \frac{\sum_i F_y}{m} = \frac{N + \|\vec{F}\| \sin 25^\circ - mg}{m} = 0 \text{ by observation}$$

when $N = 0$

$$\|\vec{F}\| = \frac{mg}{\sin 25^\circ} = \frac{5\,kg \cdot 9.8\,m/s^2}{\sin 25^\circ}$$
$$= 116\,N$$

c) $$a_x = \frac{\sum_i F_x}{m} = \frac{\|\vec{F}\| \cos 25^\circ}{m} = \frac{116\,N \cos 25^\circ}{5\,kg} = 21\ m/s^2$$

which since $a_y = 0$ is the net acceleration

5 The normal force is always $\perp$ to the surface the object is in contact with. whereas the frictional force is $\parallel$ to the surface. The normal force is just big enough to keep an object from going through the surface. The frictional force depends on the normal force, whether the object is in motion over the surface, and the kinds of surfaces in contact.

6

a the speed of the chunk at release is

$$V = 2\pi f b = 2\pi \frac{600}{min} \times \frac{1\,min}{60\,s} \times 0.3\,m$$
$$= 6\pi\ m/s$$

The velocity is pointing 30° above the +x direction. so

$$\vec{V} = 6\pi\,m/s \cos 30^\circ\,\hat{i} + 6\pi\,m/s \sin 30^\circ\,\hat{j}$$

To determine how long the chunk is in the air we use

$$y = y_0 + v_{oy} t + \tfrac{1}{2} a_y t^2$$ during the time the chunk is in free fall.

$$y_0 = b + b\cos 30^\circ$$
$$v_{oy} = 6\pi \text{ m/s} \sin 30^\circ$$
$$a_y = -9.8 \text{ m/s}^2$$
$$y = 0$$ so that

$$0 = b + b\cos 30^\circ + 6\pi \tfrac{m}{s} \sin 30^\circ\, t - 4.9 \text{ m/s}^2\, t^2$$

$$t = \frac{-6\pi \sin 30^\circ \pm \sqrt{(6\pi \sin 30^\circ)^2 + 19.6 \text{ m/s}^2\, b(1+\cos 30^\circ)}}{-9.8 \text{ m/s}^2}$$

The actual time of impact is

$$t = 1.98 \text{ s}$$

c) The velocity in the x-direction is the same as it was initially

$$V_x = 6\pi \text{ m/s} \cos 30^\circ$$

In the y-direction

$$V_y = V_{y_0} - gt = 6\pi \text{ m/s} \sin 30^\circ - 9.8 \text{ m/s}^2 \cdot 1.98 \text{ s}$$
$$= -9.98 \text{ m/s}$$

so $\vec{V} = 3\sqrt{3}\,\pi \text{ m/s}\, \hat{i} - 9.98 \text{ m/s}\, \hat{j}$

d) The displacement of the chunk is

$$\Delta\vec{r} = \vec{r}_f - \vec{r}_i$$
$$\vec{r}_i = 0\,\hat{i} + b(1+\cos 30^\circ)\,\hat{j}$$
$$= 0\,\hat{i} + 0.56 \text{ m}\,\hat{j}$$
$$\vec{r}_f = 6\pi \text{ m/s} \cos 30^\circ t\,\hat{i} + 0\,\hat{j}$$
$$= 32.3 \text{ m}\,\hat{i} + 0\,\hat{j}$$
$$\Delta\vec{r} = 32.3 \text{ m}\,\hat{i} - 0.56 \text{ m}\,\hat{j}$$