Phys100 Assignment Cover Sheet

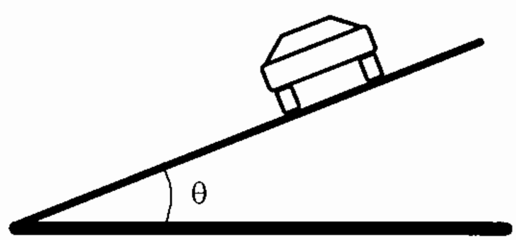
First Name:________________ Last Name:__________________ Mark:_____________

Student ID:________________ Computing ID:______________ Date:______________

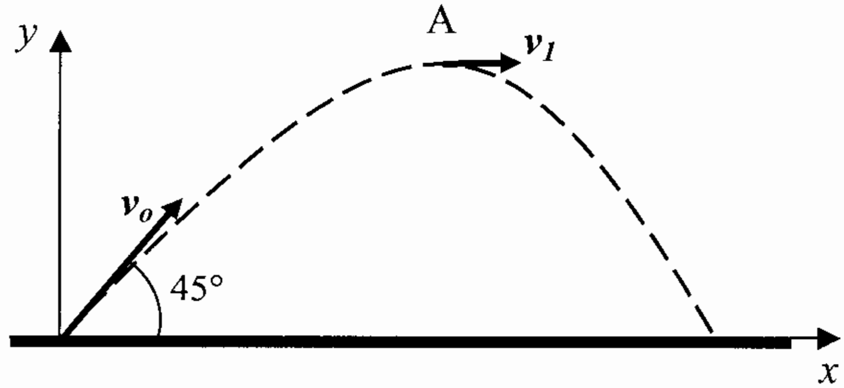
Phys100 Written Assignment #5

Due Wed Feb. 21, 2007, 9:00AM

1. Highway curves are usually banked (tilted inward) at an angle q such that the horizontal component of the normal force equals the required centripetal force.
   a) Find the proper banking angle for the car moving at 80km/h to go around a circular curve 200 m in radius.
   b) If the curve were not banked, what coefficient of friction would be required between the tires and the road?



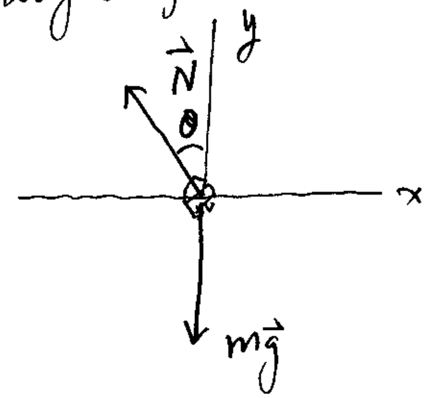
2. A ball of mass 0.5 kg is kicked into the air at an angle of 45° with an initial velocity of 30m/s. 2.0 seconds later, it reaches its maximum height at point A with a velocity of 10.0m/s to the right. Find the average acceleration of the ball in the first 2.0 seconds.

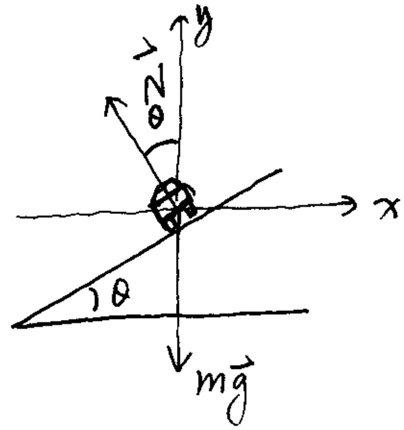


Assignment 5 solution

1.

a). Free body diagram: (Assume no friction)





$\vec{F} = m\vec{a}$ in component form:

x-comp: $-N\sin\theta = m\left(-\frac{v^2}{R}\right)$ ①

y-comp: $N\cos\theta - mg = 0$ ②

from ②: $N = \frac{mg}{\cos\theta}$

sub into ①: $-\frac{mg}{\cos\theta}\cdot\sin\theta = -m\frac{v^2}{R}$

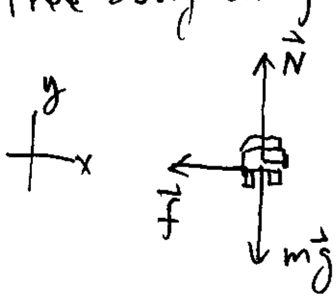
$$g\tan\theta = \frac{v^2}{R}.$$

$v = 80\,km/h$
$= 22\,m/s$

$$\theta = \tan^{-1}\frac{v^2}{gR}$$

$$= \tan^{-1}\left(\frac{22^2}{(9.8)(200)}\right) = 13.9°$$

b). Free-body diagram:



x-component: $-f = -m\frac{v^2}{R}$.

y-comp: $N - mg = 0$. $N = mg$.

$f_{max} = N\cdot\mu_s = \mu_s\cdot mg$.

$\therefore\ \mu_s mg = m\frac{v^2}{R}$. $\mu_s = \frac{v^2}{gR} = 0.25$.

2. $\vec{a}_{av} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$.

x-comp: $a_x = \frac{v_{fx} - v_{ix}}{\Delta t} = \frac{v_1 - v_0 \cos 45^\circ}{\Delta t}$

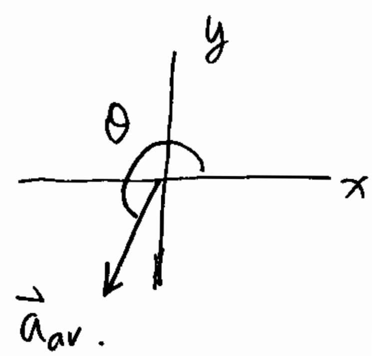
$= \frac{10.0 - 30 \cdot \cos 45^\circ}{2.0} = -5.61 \ m/s^2$.

y-comp: $a_y = \frac{v_{fy} - v_{iy}}{\Delta t} = \frac{0 - v_0 \sin 45^\circ}{\Delta t}$

$= \frac{-30 \cdot \sin 45^\circ}{2.0} = -10.6 \ m/s^2$.

magnitude:

$|\vec{a}_{av}| = \sqrt{a_x^2 + a_y^2} = 12.0 \ m/s^2$



Direction:

$\theta = \tan^{-1} \frac{a_y}{a_x} = 180^\circ + 62^\circ \doteq 242^\circ$.