Consolidation : Kinematics and Dynamics

Formula Summary

Kinematics

1. $\Delta d = \frac{V_1+V_2}{2}\Delta t$
2. $a = \frac{V_2 - V_1}{\Delta t}$
3. $\Delta d = V_1\Delta t + \frac{1}{2}a\Delta t^2$
4. $\Delta d = V_2\Delta t - \frac{1}{2}a\Delta t^2$
5. $V_2{}^2 = V_1{}^2 + 2a\Delta d$

Dynamics

Newton's Second Law

$F_{net} = ma$

Friction

$F_f = \mu F_n$

Force of Gravity

$F_g = \frac{G m_1 m_2}{r^2}$

Centripetal Force

$a_c = \frac{v^2}{r} \rightarrow F_c = \frac{mv^2}{r}$

$V = \frac{2\pi r}{T}$

Sample Problems

1. Chevy and his saucer have a combined mass of 95.9kg. They are going to go down a slope that is 52 m long and has a coefficient of friction between the saucer and hill of only 0.15, The hill has a consistent angle 38°. The hill ends at a parking lot that has just been shoveled. The coefficient of friction between the pavement and the saucer is 0.48. Chevy launches himself down the hill with an initial velocity of 3.0m/s. How far does Chevy slide along the pavement before stopping?

2. A hockey puck (mass 0.165kg) on a string is swung in a vertical circle. The string has maximum tensile strength of 12N. The radius of the circle is 0.55m and the centre of the rotation is 3.1m above the ground.
   a. what is the maximum speed the puck can be swung at before the string will break?
   b. assuming the string does break, how far will the puck travel before hitting the ground after the string breaks?

3. The International Space Station (ISS) orbits the earth at an altitude of 408km. The radius of the earth is 6,378km and the mass of the earth is 5.97×10^{24} kg.
   a. What is the period of the ISS's orbit?
   b. You want to place a satellite into orbit that has a period of 24 hours (this is called a geosynchronous orbit), at what altitude should this satellite be placed?

Sample Problems

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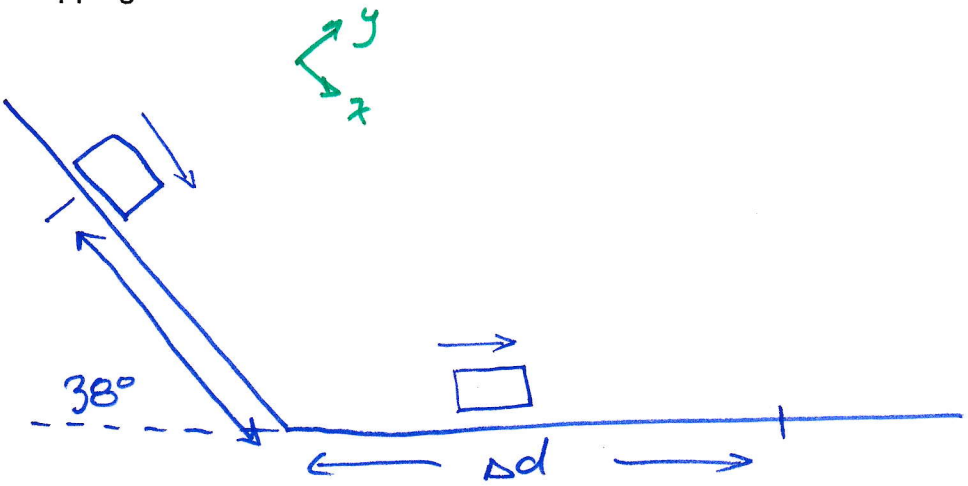
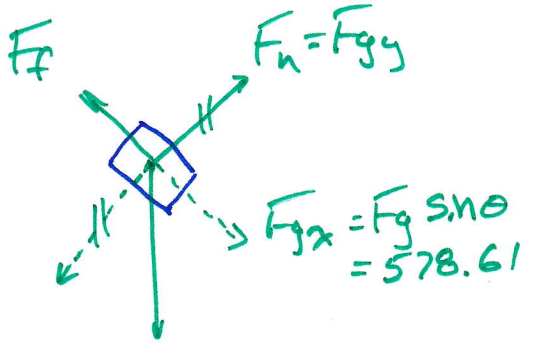




$= \mu F_n$
$= 111.09N.$

F_{gy}
$= F_g \cos\theta$
$= 740.59N$

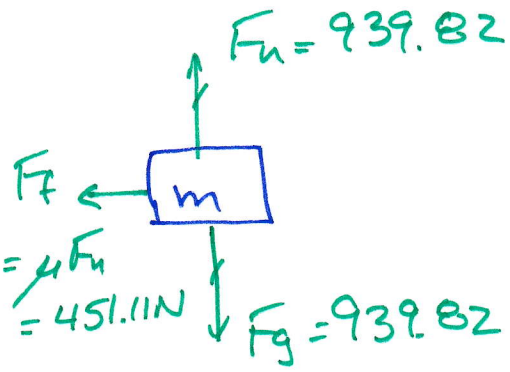
$F_{net} = F_{gx} - F_f$
$= 467.52N$

$a = F_{net}/m = 4.875 m/s^2$

$\Delta d = 52m$

$V_1 = 3.0 m/s$

⑤ $V_2 = 22.716 m/s$



$a = F_{net}/m = 4.704 m/s^2 [\leftarrow]$

$V_1 = 22.716 m/s$

$V_2 = 0$

⑤ $\Delta d = 54.85 m$

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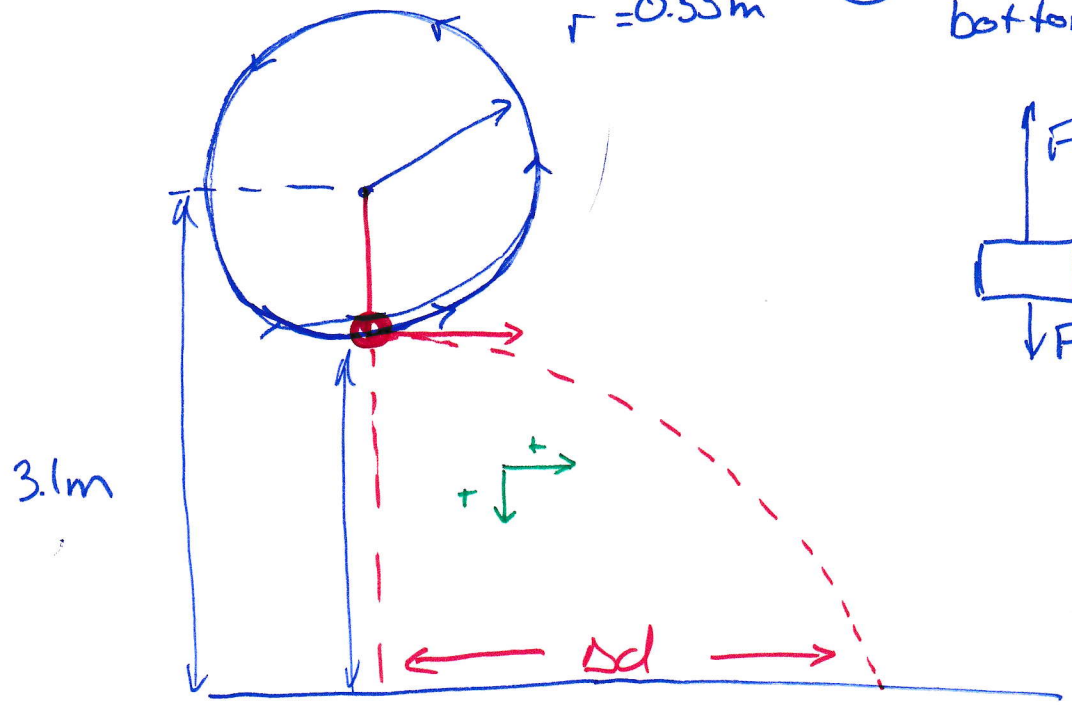

(A) maximum tension at bottom

F_T ↑, F_g ↓

$F_{net} = F_T - F_g$

$\frac{mv^2}{r} = F_T - mg$.

set $F_T = 12N$

solve for V.

$V = 5.883 m/s$

(B) horizontal launch

V: $V_{V_i} = 0$, $a = +9.8 m/s^2$, $\Delta d = 2.45m$

(3) $\Delta t = 0.707s$

H: $V_H = 5.883 m/s$

$\Delta d_H = V_H \Delta t$

$= 4.16m$

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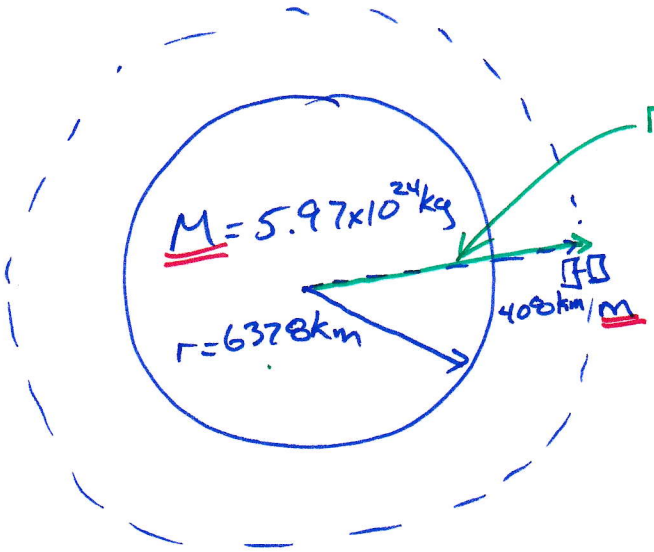

$r = 6786\text{km} = 6.786 \times 10^6 \text{m}$

$F_{net} = F_g$

$\frac{mV^2}{r} = \frac{GmM}{r^2}$

$\boxed{V^2 = \frac{GM}{r}}$ $\quad V = \frac{2\pi r}{T}$

a. $\quad * \quad T = \sqrt{\frac{4\pi^2 r^3}{GM}}$

$= 5566\,s$

$\simeq 93 \text{minutes}.$

b. $T = 24\,\text{hours} = 86400\,s$

$r = \sqrt[3]{\frac{T^2 GM}{4\pi^2}}$

$= 42.2 \times 10^7 \text{m}$

$\sim 42000\,\text{km}$