Mass, Apparent Weight, Weightlessness, Free fall and Orbit

Mass; 3 definitions

1) The amount of matter comprising an object
2) Gravitational mass: mass measured in the presence of a gravitational field
3) Inertial mass: resistance to change in motion (Newton's 1st Law)

$F_g = mg$ Newton's 1st, 2nd Laws $F_{net} = ma$ $a = 0$

g cause of acceleration $\left(\frac{N}{kg}\right)$ accel $g = 9.8\ \frac{m}{s^2}$

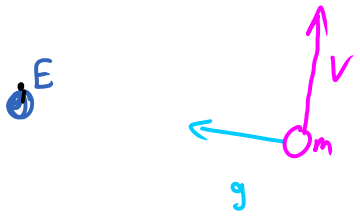
y a scale

Gravitational mass leads to a force called WEIGHT (Fg) $F_g = \vec{W}$ $W = mg$

The normal force is often called the APPARENT WEIGHT.

F_n $\vec{N}$ N

Apparent Weightlessness occurs when Fn = 0



$= 0$

Fn = 0 occurs in freefall AND in orbit

Fc = Fg

Fg = $\frac{G m_1 m_2}{r^2}$ (universal gravitational constant) $F_g = mg$

$= \frac{(6.67\times10^{-11})(5.98\times10^{24})(75)}{(6.38\times10^{6})^2} = 735\ N$ $3.75\times10^{-7}\ N$

$F_g = mg$ $(75)(9.8) = 735$

$F_g = \frac{G m_1 m_2}{r^2} = mg = F_g$ $g = \frac{G m_{obj}}{r^2}$

Top

Minimum/ maximum speeds: will have Fn or $F_T = 0$ depending on the type of circle and your FBD

$F_c = F_g + F_T$

What minimum speed at top?

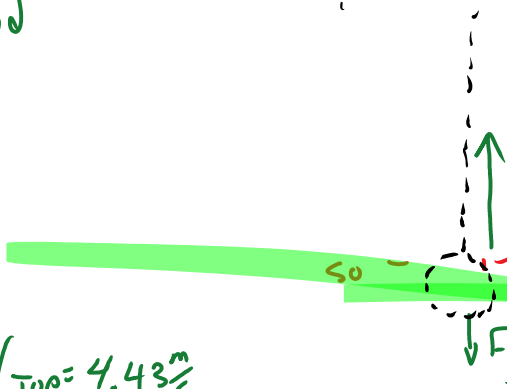
$F_c = F_g$

$\frac{mv^2}{r} = mg$

$v = \sqrt{gr}$ = $V_{top} = 4.43\ \frac{m}{s}$

Conserve Energy

F_g F_T $r = 2.0\ m$



What is F_T at the bottom?!?

$F_c = F_T - F_g$

$F_c + F_g = F_T$

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

Conserve Energy

$E_{p_0} + E_{k_0} = E_{p_f} + E_{k_f}$

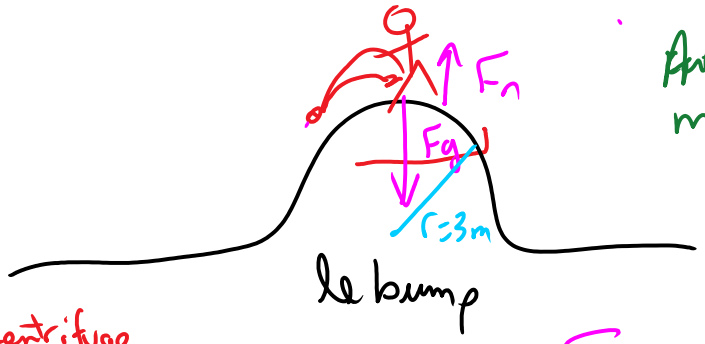
$mg\Delta h_0 + \frac{1}{2}mv_0^2 = \frac{1}{2}mv_f^2$

$2(9.8)(4) + \frac{1}{2}(4.4)^2 = \frac{1}{2}v_f^2$

$V_f = 9.88$

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

$\frac{(5)(9.88)^2}{2} + 5(9.8) = F_T$



le bump

After what tangential speed minimize the apparent weight?

ve to

$v = \sqrt{gr}$

$V = 4.4 \frac{m}{s}$

- Centrifuge
- elevator
- planets = round
- no atm = small planets

$F_c = F_g - F_n$

$\frac{mv^2}{r} = mg$ $\quad v = \sqrt{gr} = 5.4 \frac{m}{s}$

NRG

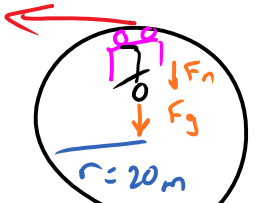
$E_{top} = E_{bottom}$

$mgh_{top} + \frac{1}{2}mv_{top}^2 = \frac{1}{2}mv_b^2$

$(9.8)(4) + \frac{1}{2}(4.4)^2 = \frac{1}{2}v_b^2$

$9.88 = v_b$

le rollercoaster



What min speed is needed so the sheeple don't fall out?

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Centrifuge $\quad F_c = F_{net}$

A bicycle rider goes over a mound of dead cats of radius 5m, feeling momentarily weightless, what velocity did the cyclist have?

$F_N = 0$

$F_g = F_c$

$$\frac{G m_e m_r}{r^2} = \frac{m_r v^2}{r}$$

r^2: orbit Planet; r: circle

$$9.8 = \frac{v^2}{5}$$

$$49 = v^2$$

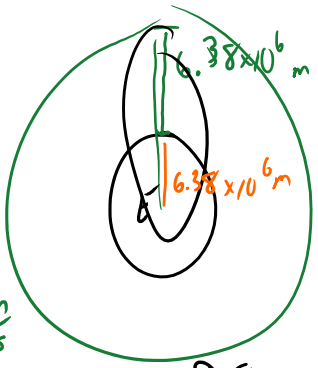
$$v = 7.0 \frac{m}{s}$$

An astronaut orbits Earth at height 6.38×10^6 m determine the orbital velocity & g at this height.

$F_c = F_g$

$$\frac{m_s v^2}{r} = \frac{G m_e m_s}{r^2}$$

$5.6 \times 10^3 \frac{m}{s}$



$$g = \frac{g_{surface}}{(\text{radius multiples})^2} = \frac{9.8}{2^2} = 2.45 \frac{N}{kg}$$

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