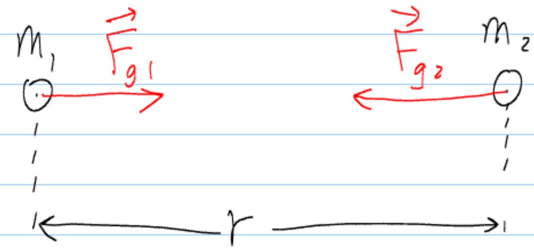
PHY131H1F Centre-screen notes
Monday Oct. 15, 2012

Universal Law of Gravity.



$$F_{g1} = F_{g2} = \frac{G m_1 m_2}{r^2}, \text{ where}$$

$G = 6.67 \times 10^{-11}$ (S.I. units)

↑ Universal constant.

r = distance between <u>centres</u> of 2 objects.

Here in Toronto, the largest, most important source of gravity is a big sphere below us (Earth)

Set $m_1 = M_{Earth}$, mass of Earth.
$r = R_{Earth}$, radius of Earth.
$m_2 = m$, the mass of some object.

$$F_g = \underbrace{\left(\frac{G M_{Earth}}{R_{Earth}^2} \right)}_{= g \text{ by definition}} m$$

$$\boxed{F_g = g\,m}$$

At sea level, $R_{Earth} = 6.37 \times 10^6$ m

$$g = \frac{6.67 \times 10^{-11} (5.98 \times 10^{24} \text{ kg})}{(6.37 \times 10^6)^2} = 9.83 \text{ m/s}^2$$

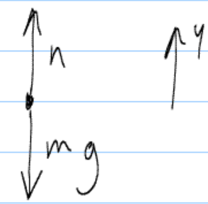
At 39 km altitude, $R = 6.37 \times 10^6 \, m + 39 \times 10^3 \, m$

$= 6.41 \times 10^6 \, m$

$g = 9.71 \, m/s^2$ ← a little smaller

When $a = 0$: $n = 824 \, N$

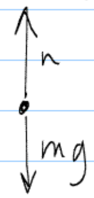
fbd:



$(F_{Net})_y = n - mg = 0$ since $a_y = 0$

$n = mg = 824 \, N.$

When $a_y = +1.5 \, m/s^2$



$(F_{Net})_y = m a_y = n - mg$

Solve for n: $n = m a_y + mg$

$$n = mg\left(1 + \frac{a_y}{g}\right)$$

$$= 824\left(1 + \frac{1.5}{9.8}\right) = \boxed{950 \, N}$$

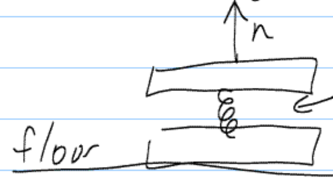
Note: in freefall, $a_y = -g$

$\Rightarrow$ weight $= mg\left(1 + \frac{-g}{g}\right) = mg(1-1)$

$= 0$ ← weightlessness!

Flour fbd.

Spring scale:



← dial is proportion to compression of spring → proportional to n.

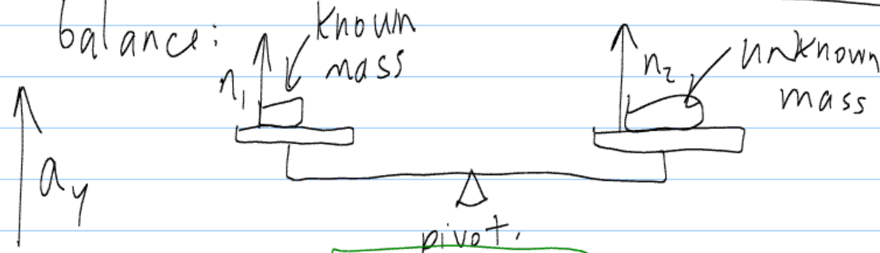
$\uparrow a_y = +1.5 \, m/s^2$

$n > mg.$

→ set n to $= (1\text{ kg})\,g$.

mg will be less than this

Pan balance:



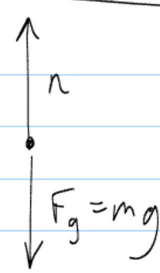
$$n_1 = m_1 g\left(1 + \frac{a_y}{g}\right)$$
$$n_2 = m_2 g\left(1 + \frac{a_y}{g}\right)$$

same effect on both pans.

→ comparing n_1 & n_2 is equiv. to comparing m_1 & m_2.

Piano;

fbd.



Constant velocity up.

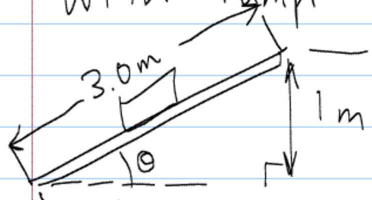
$\Rightarrow \vec{a} = 0$

$(F_{net})_y = 0 = n - mg = 0$

$n = mg = (225\text{ kg})(9.8\text{ m/s}^2)$

$\boxed{n = 2200\text{ N}}$

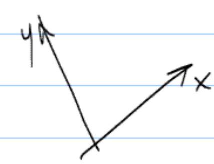
With ramp.

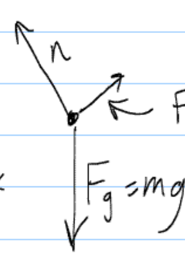


$\sin\theta = \frac{1}{3}$

fbd. of piano:

Set x, y:





F_p = pushing force (which comes from the normal force from the pusher's hands)

	x	y
$\vec{n}$	0	n
$\vec{F}_p$	F_p	0
$\vec{F}_g$	$-mg\sin\theta$	$-mg\cos\theta$
$0 = \vec{F}_{Net}$	$F_p - mg\sin\theta$	$n - mg\cos\theta$

$$F_p = mg\sin\theta = (225\text{ kg})(9.8)\left(\frac{1}{3}\right) = \boxed{735\text{ N}}$$

$$n = mg\cos\theta = \boxed{2080\text{ N}}$$