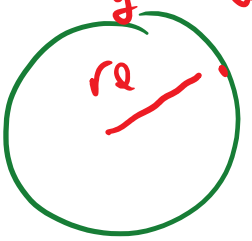
Inverse Square Law

Wednesday, March 1, 2017 10:10 AM

A powerful mathematical shortcut used when dividing by something squared AND nothing Else changes in an equation.

$F_g = \frac{G m_1 m_2}{d^2}$ ← Carter, ← Earth, d^2 ↑ r_{earth}

$F_g = \frac{6.67\times10^{-11}(65)5.98\times10^{24}}{(6.38\times10^6)^2}$



$60 \times 8\times10^9$

48×10^{10} kg

Great examples are a mass like you, and the Earth:

$= 480000000000$

$5.98000000000000000000000$

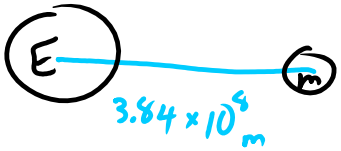
$m_{kyle} = 100$ kg

$F_g = \frac{G m_1 m_2}{d^2} = \frac{6.67\times10^{-11}(100)\,5.98\times10^{24}}{(6.38\times10^6)^2} = 979$ N (1000)

$979 \div 2^2 =$ ↑ ×2

Find new F_g with double distance $F_g = \frac{G m_1 m_2}{d^2} = \frac{6.67\times10^{-11}(100)\,5.98\times10^{24}}{(2\times6.38\times10^6)^2} = 245$ N

Find F_g between moon ($m = 7.35\times10^{22}$ kg) and Earth if Earth–moon distance is 3.84×10^8 m



$F_g = \frac{G m_1 m_2}{d^2} = \frac{6.67\times10^{-11}(5.98\times10^{24})\,7.35\times10^{22}}{(3.84\times10^8)^2}$

$= 1.99\times10^{20}$ N ← $\div 3^2$ ↑ $\div 9$

$= 2.2\times10^{19}$ N

If the distance tripled what would the new F_g be?

Ned has F_g on Earth of 490 N

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if his distance is 7 times bigger, what new F_g will exist?

$F_g = \frac{Gmm}{d^2} = \frac{490}{7^2}$ $\quad \frac{490}{7^2} = 10\,N$

A cat has $F_g = 50\,N$ at Earth's surface
if we move the cat to half the distance what would be the new F_g?

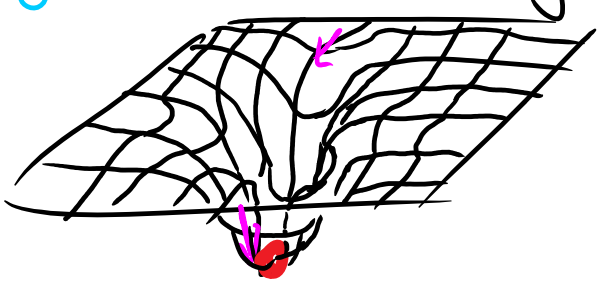
$$50 \div \left(\tfrac{1}{2}\right)^2 = 200\,N$$

A satellite has $F_g = 500\,N$ at a distance from the sun, if the distance 2.5 times larger what would be the F_g?

$$\frac{500}{2.5^2} = 80\,N$$

Gravitational field (g) is the bending of space caused by mass

$g = \frac{G m_{bending}}{d^2}$ on Earth's surface $g = 9.8\ N/kg$



Gravitational field at the "surface" of Jupiter is about 26 N/kg. What would be the gravitational field at 3 times that distance from the center?

$\frac{26}{3^2} = 2.89\ N/kg$

Mars has gravitational field of 3.43 N/kg how far in radii would you have to go to feel a gravitational field of 0.214 N/kg?

$\frac{3.43}{.214} \quad \frac{3.43}{?^2}$

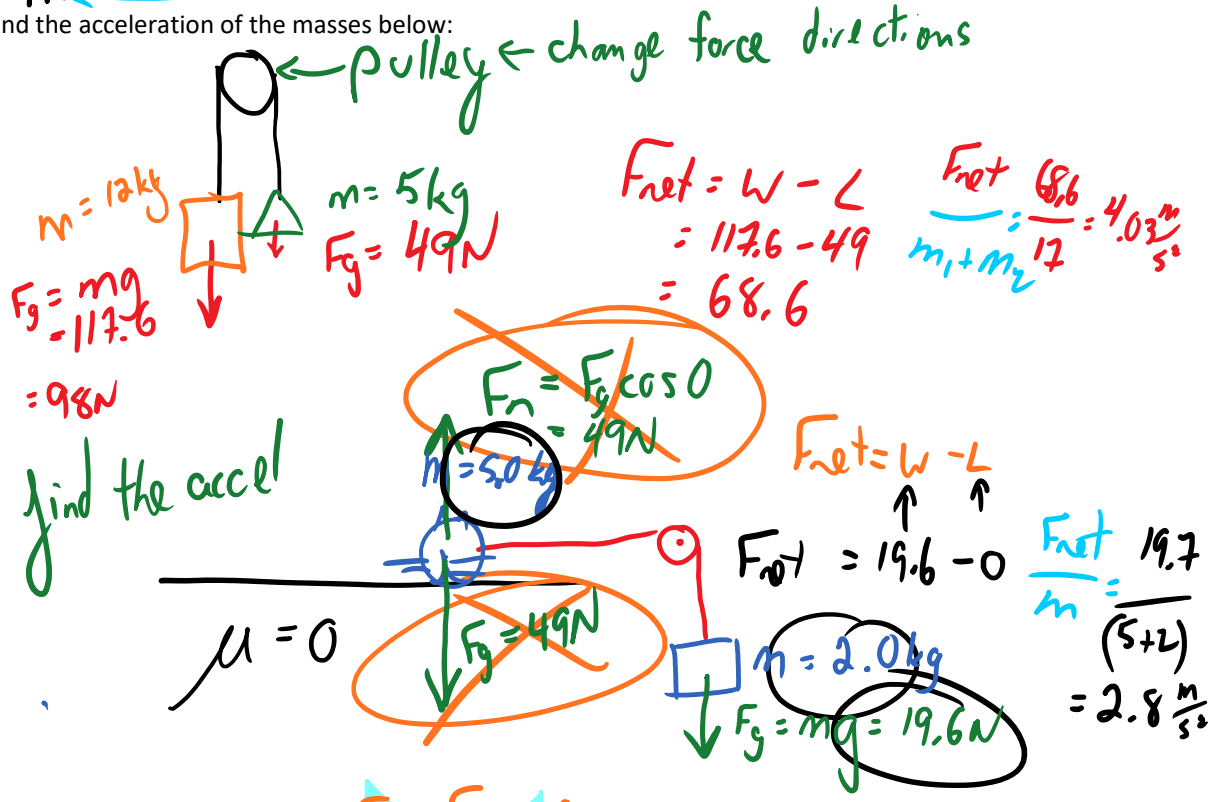
$\frac{3.43}{?^2} = .214$ $\quad \frac{3.43}{.214} = ?^2$

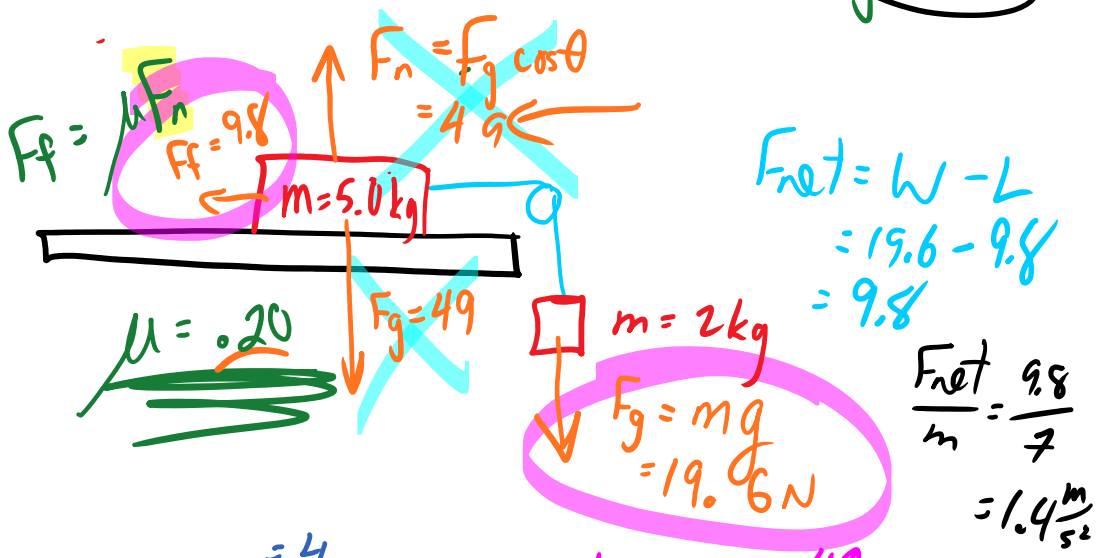
$\sqrt{16} = ?^2$

Multi-body problems

1. DRAW ALL FORCES
2. F_{net} = Winners − LOSERS
3. $\frac{F_{net}}{m} = a$ ← add all the masses

Find the acceleration of the masses below:





$a = 4$ $\quad a = \frac{F_{net}}{m}$ $\quad 4 = \frac{49}{(5+m)}$

$5 + m = \frac{49}{4} = 12.25$ $\quad 5 + m$

$5 + m_1 = \frac{49}{4} = 12.25 = 5 + m_1$

-5

$7.25\ kg = m_1$