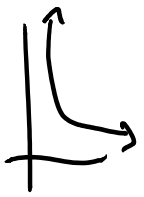
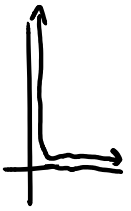
Inverse Square Law

Wednesday, February 01, 2012 8:58 AM

$y = \frac{1}{x}$  $y = \frac{1}{x^{10}}$ 

This is a mathematical shortcut to make life easy for you involving ratios. It is useful any time a formula has some variable:

$Y = \frac{\#}{X^2}$

$y = \frac{1}{x^n}$ $F_g = \frac{Gm_1m_2}{r^2}$ $\vec{g} = \frac{Gm}{r^2}$

y is inversely proportional to x^2

$y \propto \frac{a}{x^2}$

v / t = a

$v = at$

v is proportional to time.

$v \propto t$

Imagine some value of v, double the value you imagined, what happens to a?

Forget your chosen values for v, instead choose a value for t. Then double that value for t, what happens to a?

if you double one, you double the other.

$F_e = \frac{kq_1q_2}{r^2}$

$\vec{E} = \frac{kq}{r^2}$

$\frac{F_c r}{v^2} = m$ choose a value for v, that gives a value for m. double v what happens to m?

$F_c = ma$

$= m\left(\frac{v^2}{r}\right)$

$m = \frac{F_c r}{(2v)^2} \rightarrow \frac{1}{4}$

$F_g = \frac{Gm_1m_2}{r^2}$

Notice Fg depends on 1/ r^2 any formula where a variable depends on

1/ x^2 uses inverse square law.

Calculate the force of gravity on a 200 kg which is 4 x 10 ^{8} m from the center of the Earth. $F_g = \frac{6.67\times10^{-11}(200)(5.98\times10^{24})}{(4\times10^8)^2} = .5\ N$

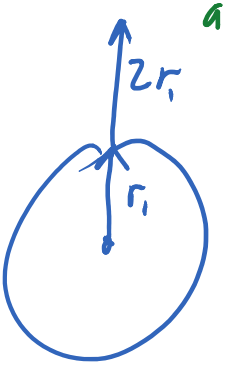
Inverse Square Law: a mathematical short cut to Fg, g, Fe, E, Intensity

Cat on Earth's surface $F_g = 500\ N$
If it is moved twice that distance
What is F_g?

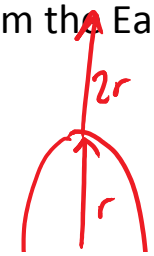
$\frac{F_{g1}}{F_{g2}} = \frac{(2r_1)^2}{r_1^2}$ $\quad \frac{500}{F_{g2}} = \frac{4r_1^2}{r_1^2}$

$F_{g2} = \frac{500}{4} = 125\ N$

$(ab)^2$
a^2b^2



Calculate the force of gravity on the same object when at 8 x 10 ^{8} m from the Earth.



$\frac{F_{g1}}{F_{g2}} = \frac{(2r)^2}{r^2}$ $\quad \frac{.5}{F_{g2}} = \frac{4r^2}{r^2}$ $\quad F_{g2} = \frac{.5}{4} = .125\ N$

F_{g2} r r_{g2} $= .125N$

useful for finding the gravitational field (g)

An exoplanet has gravitational field of 15 N / kg at its surface. What will be its gravitational field strength at 3 radii from the center.

hint : $1.67 \frac{N}{kg}$

$\vec{g} = \frac{Gm}{r^2}$

$g_1 = \frac{Gm}{r^2}$

$g_2 = \frac{Gm}{(3r)^2}$

$\frac{g_1}{g_2} = \frac{(3r)^2}{r^2}$

$\frac{15}{g_2} = \frac{9}{1}$

$g_2 = 1.67 \frac{N}{kg}$

A star has a planet orbitting it, and experiences a force of gravity of 5.0×10^{40} N between the two. If the separation magically doubled how many times greater is Fg1 compared to Fg2?

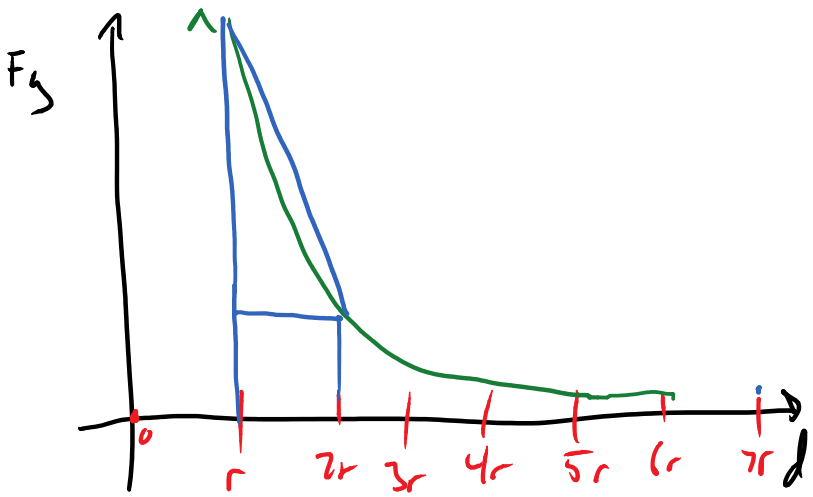
and, what is F_{g2} hint: $F_{g2} = 1.25 \times 10^{40}$

The force on a mass on Jupiters surface is 100 N. What is the force at 5 times the distance? hint: 4N

distance! hint: 4N

$$\frac{100}{r^2} = 4$$

Inverse Square Law

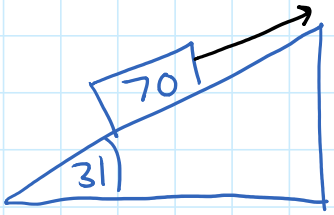


Work from
$r \rightarrow 2r$
→ Area under the graph

Cool Question

Monday, April 18, 2016 10:45 AM

An Electric motor outputs 1500W of power
Pulling a 70kg crate of fish up a very slippery loading ramp at a constant speed. The ramp is inclined 31 degrees to the horizontal. Determine the speed of the crate. (ignore friction)



$V = ?$

hint: $4.29\ m/s$

$F_{down} = m g \sin(\theta)$

$= 70(9.8)\sin(31)$

$= 353\ N \rightarrow F_{up.}$ (constant velocity)

$P = \frac{W}{t}$

$1500 = \frac{W}{t}$

$1500t = F d$

$1500 = 353\left(\frac{d}{t}\right)$

$1500 = 353\ v$

$\frac{1500}{353} = v$

$4.29\frac{m}{s} = v$