Gravity, Normal Forces and Frictional Forces

September 5, 2015 7:48 AM

Force of Gravity (on the surface of the earth)

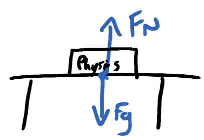
$F_g = \frac{-Gm_1m_2}{d^2}$ *on the surface of the earth this equates to* $F_g = mg$

$G = 6.67 \times 10^{-11}\ N.m^2/kg^2$: Universal Gravitational Constant
$m_e = 5.97 \times 10^{24}$ kg : Mass of the earth
$d_e = 1.74 \times 10^{6}$ m : Average Radius of the earth

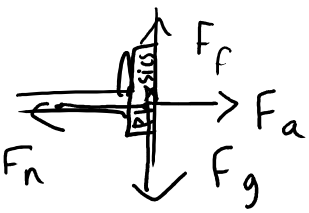
Normal Force: Comes from Newton's third law. It is a force that comes perpendicular to the surface in contact. (90°)

F_N : Normal Force

Ex: book on a table



Ex: book pushed against a wall



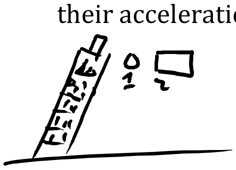
a = 0 in all these examples

Frictional Force (This force opposes motion, but NEVER causes motion)

$F_f = \mu F_N$

μ : Coeffiecent of friction between two surfaces. It depends on the "roughness" of the two materials in contact.

Example: Galilep dropped A 5kg object and a 100kg off a tower. Ignoring air resistance, calculate their accelerations.



object 1

$\downarrow F_g$

$F_{net} = ma$
$-F_g = ma$
$-\cancel{m}g = \cancel{m}a$
$-g = a$
$-9.8\,m/s^2 = a$

The masses cancelled so this will work with any mass

Example: A 77kg persons weighs themselves on the surface of earth ($g=9.80m/s^2$) as well as on the surface of Jupiter ($g=98.0m/s^2$). How does their mass and weight change.

mass → does not change

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m: mass → does not change

F_g: weight → does change

earth

$F_g = (77)(9.8)$

$= 755N$

weight = 755N

mass = 77kg

Jupiter

$F_g = (77)(98)$

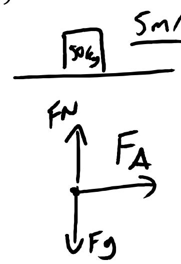
$= 7550N$

weight: 7550N

mass: 77kg

Example: A 50kg box is pushed along a frictionless surface. The box accelerates at a rate of $5m/s^2$.

a) Calculate the force used to push the box.



Horizontal

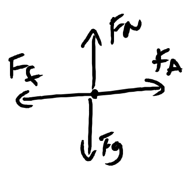
$F_{Net} = ma$

$F_A = ma$

$= (50)(5)$

$F_A = 250N$

b) What would be the acceleration if the force of friction is 147N?



Horizontal

$F_{Net} = ma$

$F_A - F_f = ma$

$250 - 147 = (50)(a)$

$\frac{103}{50} = \frac{50a}{50}$

$\boxed{2.06m/s^2 = a}$

c) What would be the coeffiecent of friction?

$F_f = 147$

$m = 50kg$

$F_f = \mu F_N$

$147 = \mu F_g$

$147 = \mu mg$

$147 = \mu (50)(9.8)$

$\mu = \frac{147}{(50)(9.8)}$

No acceleration in the vertical

Vertical ($a=0$)

$F_{Net} = ma$

$F_N - F_g = m\cancel{a}$ 0

$F_N = F_g$

$$\boxed{\mu = 0.3}$$

work on problems
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