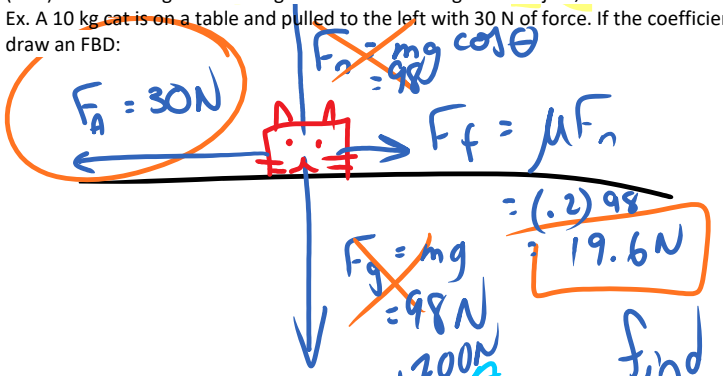
Newton's Laws

Friday, November 12, 2010 12:27 PM

Newton's laws are the laws which describe acceleration of objects based on the forces acting upon the object. Dynamics is the study of accelerating objects, the accel of which is found using the forces acting on the object. Force is a vector measured in units of newtons (N) and it is a compound unit meaning the newton is composed of smaller units. Specifically N = kg m / s^2.

The best method of proceeding in a problem involving various forces is to draw a FREE BODY DIAGRAM (FBD). This is a diagram showing all real forces acting on an object, outward from the object itself.
Ex. A 10 kg cat is on a table and pulled to the left with 30 N of force. If the coefficient of friction is 0.20 draw an FBD:



$F_{net} = 30 - 19.6$

$F_{net} = W - L$ .6

$F_{net} = 10.4N$

$a = \frac{F_{net}}{m} = \frac{10.4}{10} = 1.04 \frac{m}{s^2}$ 4

left

find a

A gorilla of mass 200 kg is on a 30° slope, with coefficient of friction of 0.40, draw an FBD.

$= 1700N$

$mg\cos\theta$

$F_f = \mu F_n = 6$ N

F_{net}

NEWTON'S Laws

direct multiple

of ces

Newton's Second Law states the acceleration of a mass is in the direction of the unbalanced force acting upon it, the magnitude of the acceleration is directly proportional to the size of the unbalanced force, and inversely proportioned to the object's mass. Unbalanced force is another name for Fnet (total of all forces)

÷ mass

$$\frac{F_{net}}{m} = a$$

Newton's 2nd Law may be expressed with the equation: $\frac{F_{net}}{m} = a$

Find the acceleration of the cat in the first example AND the gorilla in the 2nd example:

a

m

$F_{net} = 0$

$F_{net} = 0$

$\frac{F_{net}}{} = a$

Newton's First Law (aka the law of inertia) states that if an object experiences no unbalanced force (meaning all forces are balanced) then it will remain at a constant velocity, it has no acceleration. In reference to the 2nd law, if Fnet = 0 then a = 0 as well

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$\frac{F_{net}}{m} = a$

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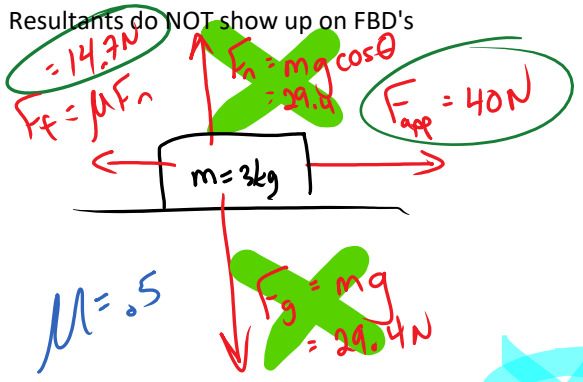
Free Body Diagrams (FBD): show all TRUE forces acting on a mass, drawn OUTWARD from the mass
Resultants do NOT show up on FBD's



$\mu = .5$

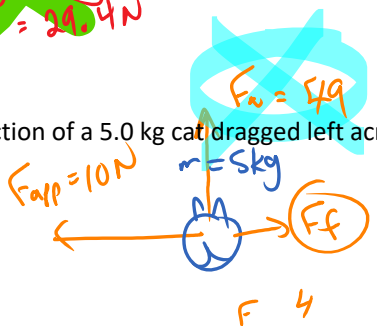
find F_{net} & a

$F_{net} = W - L$
$= F_{app} - F_f$
$= 40 - 14.7$
$= 25.3N$

$\frac{F_{net}}{m} = a$

$\frac{25.7}{3} = 8.33 \frac{m}{s^2}$ Right

Find the coefficient of friction of a 5.0 kg cat dragged left across a level surface at a constant speed, using A force of 10.0 N.



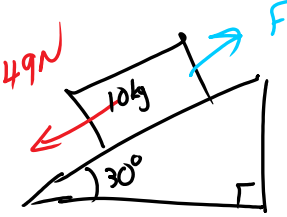
$F_{net} = W - L$
$= 10 -$
$-$

$a = 0$

$F_{net} = W - L$
$= 49 - 17$
$= 32N$

$a = \frac{F_{net}}{m} = \frac{32}{10} = 3.2 \frac{m}{s^2}$ down el ramp

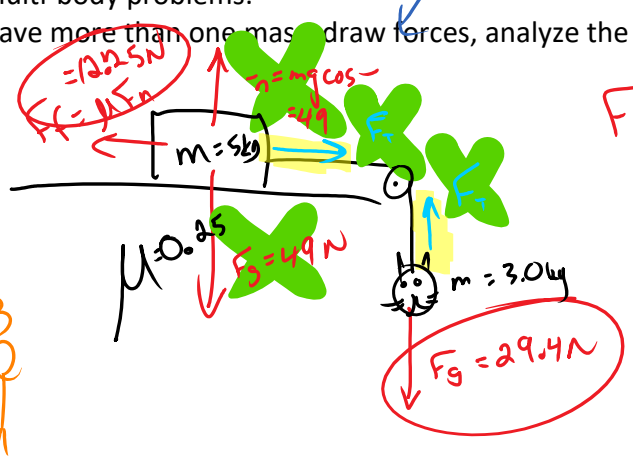
$F_{down} = 49N$



$F_f = \mu F_n$
$= (.2)\,85$
$= 17$

$\mu = 0.2$ find accel

Multi-body problems:
Have more than one mass, draw forces, analyze the force to find Fnet, find accel



$F_{net} = W - L$
$= F_g - F_f$
$= 29.4 - 12.25$
$= 17.15N$

$\frac{F_{net}}{m} = \frac{17.15}{8} = 2.13 \frac{m}{s^2}$

Use total mass

Newton's Third Law states that if any object A exerts a force on another object B, then B must exert an equal but opposite force on A.

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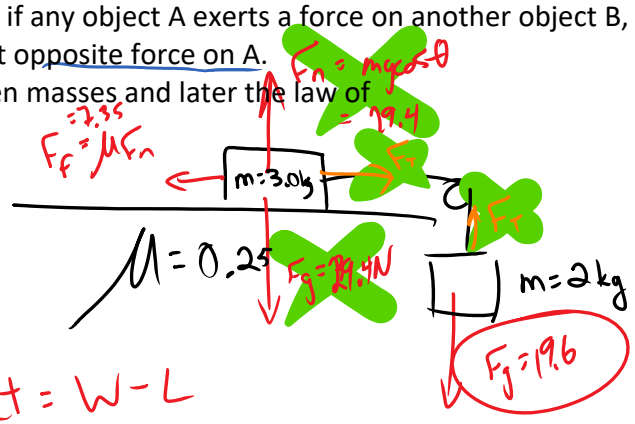
This gives rise to forces between masses and later the law of conservation of momentum.

find accel of 3kg (A→L), 2kg (m→Z)



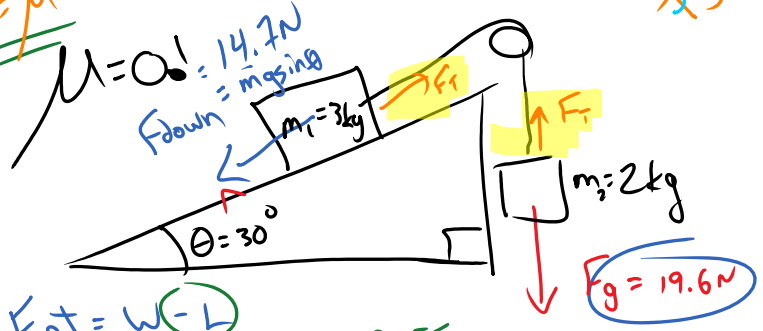
$F_{net} = W - L$

$= .1\ 25.5 = 2.55N$

$F_f = \mu F_n$

$= \frac{12.35N}{5} = 2.4\ \frac{m}{s^2}$

$\frac{12.25}{2} = 6.13$



find accel of 2kg mass

$F_{net} = W - L$
$= 19.6 - 14.7 - 2.55$
$= 2.35N$

$a = \frac{F_{net}}{m} = \frac{2.35}{5} = .47\ \frac{m}{s^2}$

The acceleration of multi - body systems:

1. Label all forces acting on every body in the system
2. Find the total force (Fnet) by thinking which forces work together, or against one another
3. Use Newton's 2nd Law to find acceleration

F_{g1} F_{net} $F_g = 9800N$

$F_{up} - F_{net} = W - L$

$F_{net} = F_{up} - 9800$ $F_{g2} - F_f$

$3000 = F_{up} - 9800$

$= ma$

$12800N = F_{up}$

A rock of mass 2.0 kg is thrown upward with a force of 36 N, what is its initial acceleration while
Being thrown?