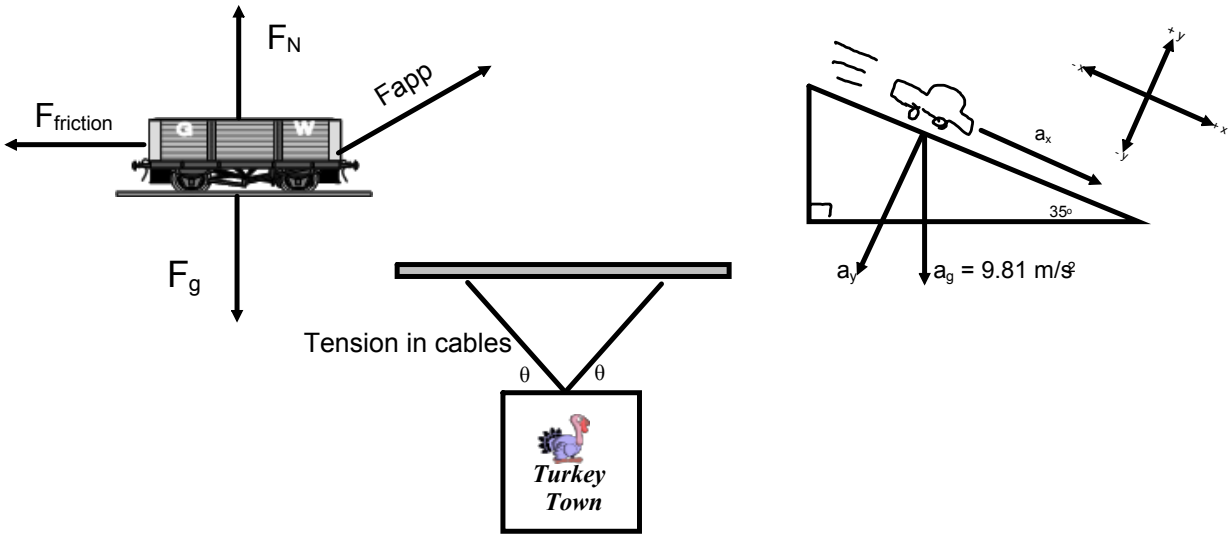
March 24, 2014

Three Types of Force Problems

1 - Pushing or pulling an object along a horizontal surface.
2 - Tension and hanging signs.
3 - Objects on an incline.



Changes from Physics 112:

- Friction can be opposite applied force.
- Normal force is not the same value as the force of gravity.
- We must carefully analyze all the forces.

definition of equlibrium: *the state of an object when the vector sum of all the forces acting on it is zero.*

If an object is at ***rest*** and is in ***equilibrium***, then we say that it is in a state of "***static equilibrium***."

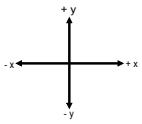
<u>Equilibrant:</u> is the one vector, when added to 2 or more other vectors produces a state of equilibrium. It is equal to the resultant but opposite in direction.

<u>Try</u> - Three forces act simultaneously on point P. The first force is 10 N east. The second force is 15 N south. The third force is 28 N, E46^{o}S . Find the resultant force. (46 N, E50^{o}S). Find the equilibrant.(46N, W50^{0}N)

Force Problems - Type I

A 55 kg snow blower is pushed along the ground at an angle of 35° to the horizontal with an applied force of 175 N.

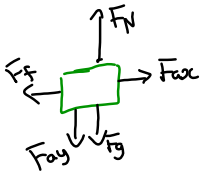
a) Find the F_{ax} and F_{ay}.
b) Calculate F_N.
c) Find the force of friction if $\mu = 0.19$.
d) Find the F_{netx}.
e) Find a_x.



a) $F_{ax} = F_a \cos\theta$
$= 175 \cos 35^\circ = 143.4$ N

$F_{ay} = F_a \sin\theta$
$= -175 \sin 35^\circ = -100.3$ N (downward)

b) $F_N = ?$ Use F_{nety}



$F_{nety} = \sum$ Forces in y-direction

$F_{nety} = 0$ N (no motion in y-d.r.)

$F_{nety} = F_g + F_N + F_{ay}$ *$F_g = mg = (55)(9.81)$

$0 = (-539.5) + F_N + (-100.3)$

$0 = -639.8 + F_N$

$639.8 \text{ N} = F_N$

c) $F_f = ?$

$F_f = \mu F_N$

$|F_f| = (0.19)(639.8)$
$= 121.6$ N

d) $F_{netx} = ?$ $F_{netx} = \sum$ Forces in x-dir

$F_{netx} = F_{ax} + F_f$
$= 143.4 + (-121.6)$
$= 21.8$ N

e) $a_x = ?$ $F_{netx} = m a_x$

$21.8 \text{ N} = (55) a_x$

$0.4 \text{ m/s}^2 = a_x$

A 35 kg wagon is pulled along the ground at an angle of 25^{o} to the horizontal with an applied force of 97 N.

a) Find the F_{ax} and F_{ay}.

b) Calculate F_N.

c) Find the force of friction if $\mu = 0.22$.

d) Find the F_{netx}.

e) Find a_x.

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Force Problems - Type I

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17. A student pushes a 25 kg lawn mower with a force of 150 N. The handle makes an angle of 35° to the horizontal.

(a) Find the vertical and horizontal components of the applied force.

(b) Calculate the normal force supporting the lawn mower while it is being pushed.

(c) Calculate the net force propelling the mower if a frictional force of 85 N exists.

(d) Calculate the horizontal acceleration of the lawn mower. (Remember: Only part of the $F_{applied}$ is parallel to the direction of horizontal acceleration.)

a) 86 N, down
1.2 x 10^2 N, right
b) 3.3 x 10^2 N, up
c) 38 N, right
d) 1.5 m/s^2, right

24. A toboggan with a mass of 15 kg is being pulled with an applied force of 45 N at an angle of 40° to the horizontal. What is the acceleration if the force of friction opposing the motion is 28 N?

0.43 m/s^2, right

25. A grocery cart is being pushed with a force of 450 N at an angle of 30.0° to the horizontal. If the mass of the cart and the groceries is 42 kg,

(a) Calculate the force of friction if the coefficient of friction is 0.60.

(b) Determine the acceleration of the cart.

a) 3.8 x 10^2 N, left
b) 0.23 m/s^2, right

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36. A 45.0 kg box is pulled with a force of 205 N by a rope held at an angle of 46.5° to the horizontal. The velocity of the box increases from 1.00 m/s to 1.50 m/s in 2.50 s. Calculate

(a) the net force acting horizontally on the box.

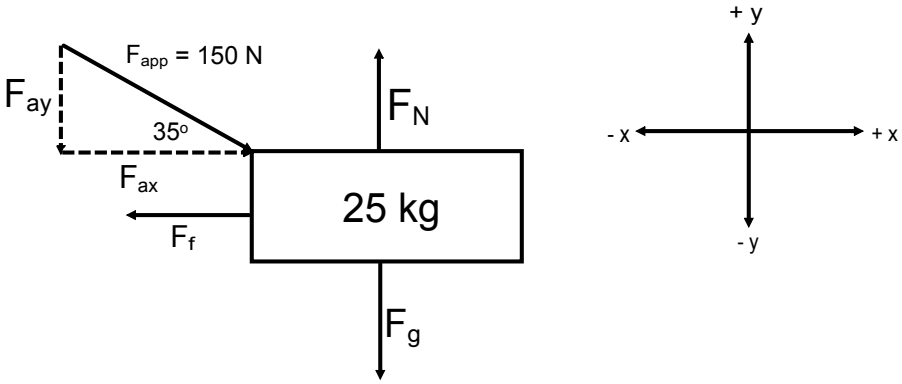
(b) the frictional force acting on the box.

(c) the horizontal component of the applied force.

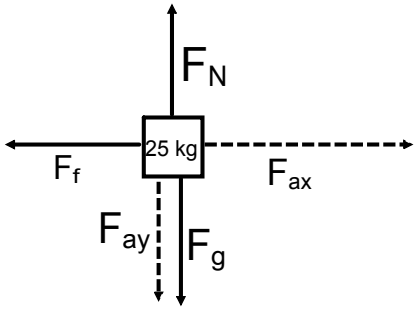
(d) the coefficient of kinetic friction between the box and the floor.

a) 9.0 N, right
b) 132 N, left
c) 141 N, right
d) 0.451

#17



Free Body Diagram



(a) F_{ax} = +150cos(35)
= 123 N

F_{ay} = -150sin(35)
= -86 N

(b) $F_{nety} = F_{ay} + F_g + F_N$
$0 = -86\ N - mg + F_N$
$0 = -86 - 25(9.81) + F_N$
$0 = -86 - 245.25 + F_N$
$0 = -331.25 + F_N$
$+330\ N = F_N$

(c) F_{netx} = Sum of horizontal forces
$= F_{ax} + F_f$
= 123 + -85
= + 38 N

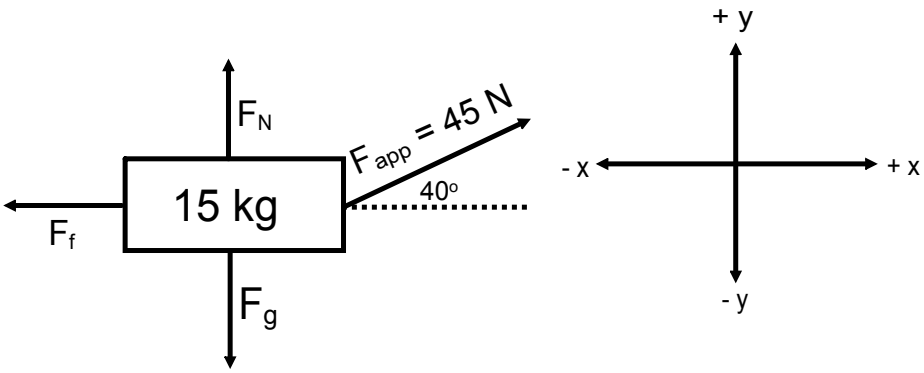
(d) $F_{net} = ma$

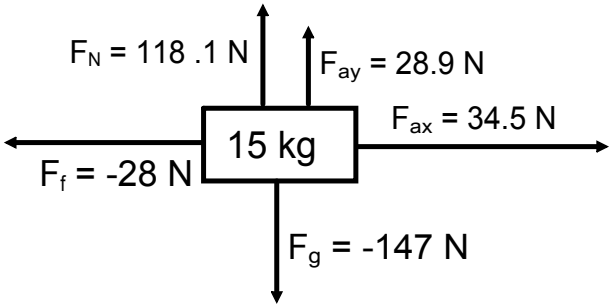
$$a = \frac{F_{net}}{m}$$

$$a = \frac{+38\ N}{25\ kg}$$

a = +1.5 m/s^2

 # 24





$F_{netx} = F_{ax} + F_f$

$= 34.5 + (-28)$

$= +6.5\ N$

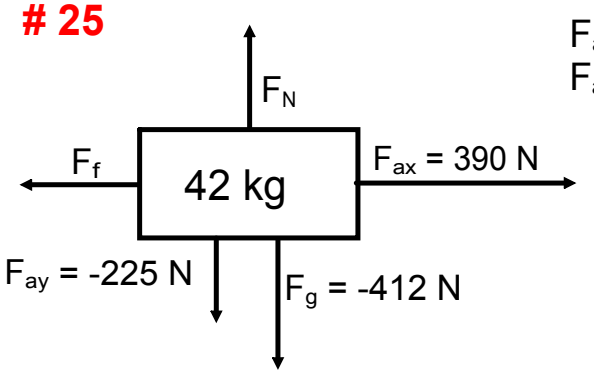
$$F_{net} = ma$$

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

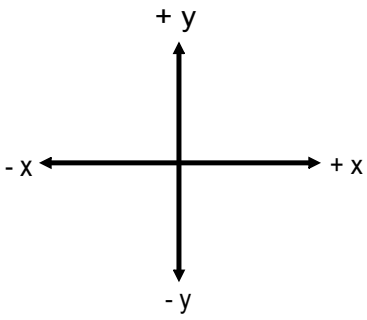
$a = +6.5\ N/15\ kg$

$a = +0.43\ m/s^2$

 # 25



$F_{ax} = 450\cos(30)$ N
$F_{ay} = 450\sin(30)$ N



(a) $F_f = \mu F_N$, $\mu = -0.60$

$F_{nety} = F_{ay} + F_g + F_N$
$0 = -412\text{ N} + -225\text{ N} + F_N$
$F_N = +637\text{ N}$

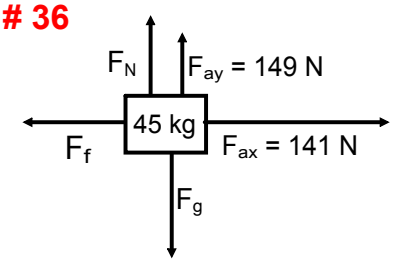
$F_f = 0.60(637\text{ N})$
$F_f = 380\text{ N [left]}$

(b) $a = \dfrac{F_{net}}{m} = F_{ax} + F_f$

$a = (389.7\text{ N} + -382\text{ N}) \div 42\text{ kg}$

$a = +0.19\text{ m/s}^2$

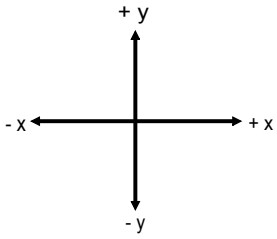
 # 36



F_{app} = 205 N @ 46.5°

F_{ax} = 205cos(46.5)

F_{ay} = 205sin(46.5)



(a) $F_{net_x} = ma_x$ ← find acceleration

$$a = \frac{\Delta v}{\Delta t}$$

$$a = \frac{1.50m/s - 1.00m/s}{2.50s}$$

a = 0.20 m/s^2

F_{net} = (45kg)(0.20m/s^2)
= 9.0 N

(c) F_{ax} = 141 N

(d) $F_{kf} = \mu F_N$

$F_{nety} = F_{ay} + F_g + F_N$
0 = -441 N + 149 N + F_N
F_N = +292 N

$$\mu = \frac{F_f}{F_N}$$

can use "+132" as the formula implies the magnitude of F_f.

$$\mu = \frac{+132N}{292N}$$

μ = 0.451