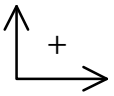
P11 - 3.1 - $F = ma$ Newton's Laws Notes



Force - A Push or pull

Four Fundamental Forces
1.Gravitational P11
2.Electromagnetic (e^-)
3.Strong Nuclear (keeps p^+ in nucleus)
4.Weak Nuclear (Radioactive Decay)

Force of Gravity - Attracts Matter to Matter
Matter - Anything that has Mass and takes up space.
Mass - Amount of Matter an object holds
Weight - The force of Gravitational Attraction

Mass is **constant** throughout the universe.
Weight **depends** on your location. (Earth, Moon, Space …)
g, depends on the m of the planet and d from it's centre

Units: Newton's (N)

$1\ Newton: The\ force\ required\ to\ accelerate\ a\ 1kg\ object\ at\ 1\frac{m}{s^2}.$

$$1N = \frac{1kgm}{s^2} \quad F = ma \quad N = kg\frac{m}{s^2}$$

Newton's 3 Laws:

Including at rest

1 Inertia - An object will continue at a constant velocity, unless acted upon by a non-zero sum force.

$F_{net} = ma$ 2 The sum of the forces in the direction of motion, minus opposing forces. $\Sigma F = ma$ $F_a - F_f = ma$ (Winners minus losers.)

Tug of War

3 Every force has an equal and opposite force. (You push me, I push back)

The Gravitational Force: $F_g = mg$

$F_g: Force\ of\ Gravity, (Gravitational\ Force)$
$m: Mass$
$g: Gravity$

$g = -9.8\frac{m}{s^2}$ $\frac{N}{kg} = \frac{m}{s^2}$

$What\ is\ the\ Pull\ Force\ required\ to\ accelerated\ a\ 15kg\ object\ at\ 2\frac{m}{s^2}?$

1 $a = 2\frac{m}{s^2}$, $F_p = ?$, 15

$F_n: Normal\ Force\ (Weight)$
$F_p: Force\ Pull$
$F_f: Force\ of\ Friction$

2 FBD Free Body Diagram:

$F_n = F_g^*$
$F_n = 147N$
$F_n = F_g^*, \theta = 0$

$F_f = 0$, $F_p = ? = 30N$

3
$F = ma$
$F = (15)(2)$
$F = 30\ N$

$F_{net} = ma$
$F_p - F_f = ma$
$F_p - 0 = 15 \times 2$
$F_p = 30\ N$

We were actually supposed to subtract a non-existent Frictional Force.

1st
$F_g = mg$
$F_g = 15 \times 9.8$
$F_g = 147\ N$

$g = 9.8\frac{m}{s^2}$

$+ve\ downward!$

$What\ is\ the\ Pull\ Force\ required\ to\ Accelerated\ a\ 15kg\ object\ at\ 2\frac{m}{s^2}, with\ a\ F_f\ of\ 3\ N?$

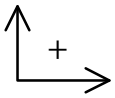
$a = 2\frac{m}{s^2}$, $F_f = 3$, $F_p = ? = 33N$, 15

$F = ma$
$F_p - F_f = ma$
$F_p - F_f = ma + F_f$
$F_p = 30 + 3$
$F_p = 33\ N$

$Obviously\ 3\ more\ Newton's\ than\ without\ Friction = 3N.$

FBD
$F_n = 147N$
$F_f = 3$, $F_p = ? = 33N$
$F_g = mg$
$F_g = 15 \times 9.8$
$F_g = 147\ N$

P11 - 3.2 - $F = ma, F_f = \mu F_n$ Solve Variable Notes



A Pull Force of 45 N is applied to a 15kg object. Find its acceleration.

$a = ? = 3$

$F_p = 45$

15

FBD

$F_n = 147N$

$F_f = 0$

$F_p = 45N$

$F_g = mg$

$F_g = 15 \times 9.8$

$F_g = 147\ N$

$F = ma$

$a = \frac{F}{m}$

$a = \frac{45}{15}$

$a = 3\frac{m}{s^2}$

A Push Force of 12 N on an object's $a = 2\frac{m}{s^2}$, Find object's Mass and Weight?

$a = 2\frac{m}{s^2}$

$F_p = 12$

6

FBD

$F_n = 58.8N$

$Weight = F_n$

$F_f = 0$

$F_p = 12N$

$F_g = mg$

$F_g = 6 \times 9.8$

$F_g = 58.8\ N$

$F = ma$

$m = \frac{F}{a}$

$m = 6\ kg$

Cross it out

A Pull Force of 92 N on a 15 kg object's $a = 5\frac{m}{s^2}$. What is the Frictional Force?

$a = 5\frac{m}{s^2}$

$F_f = ?$

$F_p = 92$

15

FBD

$F_n = 147N$

$F_f = ? = 92$

$F_p = 92N$

$F = ma$

$F_p - F_f = ma$

$F_f = F_p - ma$

$F_f = 92 - 15 \times 5$

$F_f = 17\ N$

$F_g = mg$

$F_g = 15 \times 9.8$

$F_g = 147\ N$

How far did the object go in 5s?

Acceleration is the Kinematics - Dynamics Link

$\Delta d = v_i t + \frac{1}{2}at^2$

$d = (0)t + \frac{1}{2}(5)(5)^2$

$d = 62.5\ m$

t	d
0	0
1	2.5
2	10
3	22.5
4	40
5	62.5

What is the velocity after 2 seconds?

$v_f = v_i + at$

$v_f = 0 + 5(2)$

$v_f = 10\frac{m}{s}$

How long until it reaches $25\frac{m}{s}$.

$v_f = v_i + at$

$25 = 0 + 5t$

$t = 5s$

t	v
0	0
1	5
2	10
3	15
4	20
5	25

Find the Push Force to $a = 2\frac{m}{s^2}$ a 15kg object, with a Frictional Co − efficint of $\mu = 0.3$?

$a = 2\frac{m}{s^2}$

$F_f = ? = 44.1$

$F_p = 92$

15

$\mu = 0.3$

FBD

$F_n = 147N$

$F_f = ? = 44.1$

$F_p = 74.1N$

$F_g = mg$

$F_g = 15 \times 9.8$

$F_g = 147\ N$

$F_f = \mu F_n$

$F_f = \mu F_n$

$F_f = 0.3 \times 147$

$F_f = 44.1\ N$

$F = ma$

$F_p - F_f = ma$

$F_p = ma + f_f$

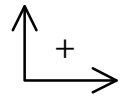
$F_p = 15 \times 2 + 44.1$

$F_p = 74.1\ N$

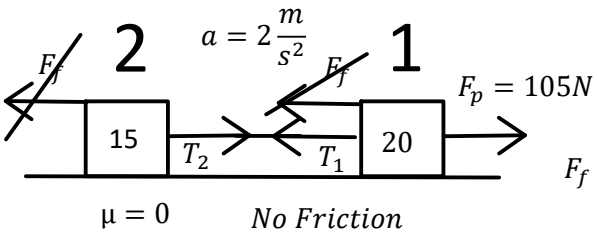
μ : Frictional Co − efficient (Mhew) No Units.

Higher the Mhew, μ, Higher the Frictional Force.

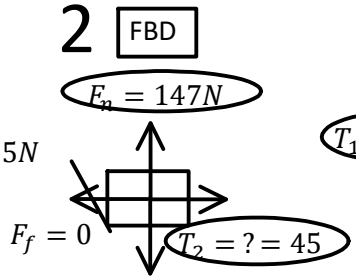
P11 - 3.3 - Tension Notes



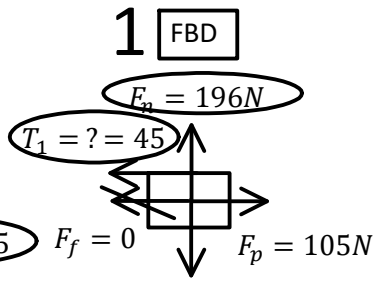
Find T_1 and T_2



$\mu = 0$ *No Friction*



$F_g = mg$
$F_g = 15 \times 9.8$
$F_g = 147\ N$



$F_g = mg$
$F_g = 20 \times 9.8$
$F_g = 196\ N$

System | *Mass of system*

$$F = ma$$
$$F - T_1 - F_f + T_2 - F_f = ma$$
$$105 - T_1 - F_f + T_2 - F_f = (15 + 20)a$$
$$105 = 35a$$
$$a = 3\frac{m}{s^2}$$

$T_1 = T_2$

Mass 2

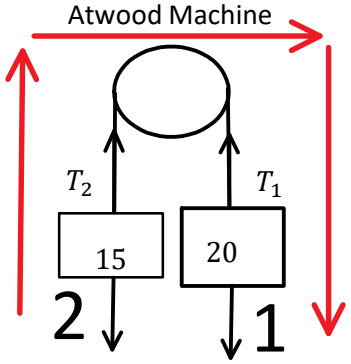
$$F = ma$$
$$T_2 - F_f = ma$$
$$T_2 - 0 = 15 \times 3$$
$$T_2 = 45\ N$$

Mass 1

$$F = ma$$
$$F - T_1 - F_f = ma$$
$$105 - T_1 - F_f = 20 \times 3$$
$$T_1 = 45\ N$$

Tension must be equal!

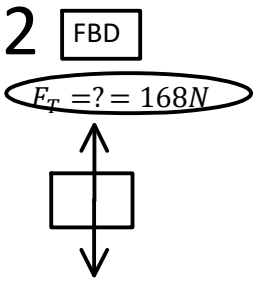
Atwood Machine



$F_g = mg$
$F_g = 15(9.8)$
$F_g = 147\ N$

$F_g = mg$
$F_g = 20(9.8)$
$F_g = 196\ N$

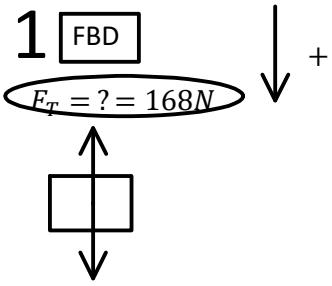
$$F = ma$$
$$Fg_1 - T_1 + T_2 - Fg_2 = ma$$
$$196 - T_1 + T_2 - 147 = (15 + 20)a$$
$$49 = 35a$$
$$a = 1.4\frac{m}{s^2}$$



$F_g = mg$
$F_g = 15 \times 9.8$
$F_g = 147\ N$

Mass 2

$$F = ma$$
$$T_2 - F_g = ma$$
$$T_2 = ma + F_g$$
$$T_2 = 15 \times 1.4 + 147$$
$$T_2 = 168\ N$$



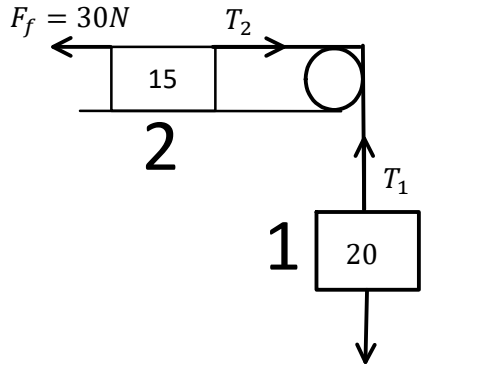
$F_g = mg$
$F_g = 20 \times 9.8$
$F_g = 196\ N$

Mass 1

$$F = ma$$
$$F_g - T_1 = ma$$
$$T_1 = F_g - ma$$
$$T_1 = 196 - 20 \times 1.4$$
$$T_1 = 168\ N$$

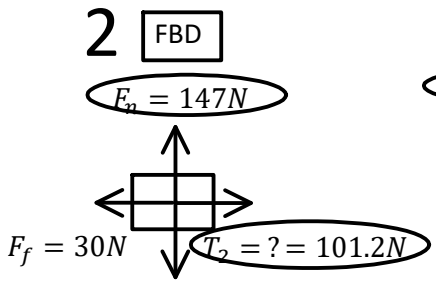
P11 - 3.3 - Tension Notes

Find T_1 and T_2



$F_g = mg$
$F_g = 20(9.8)$
$F_g = 196\ N$

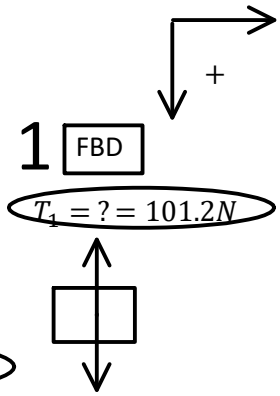
$F = ma$
$F_g - T_1 + T_2 - F_f = ma$
$196 - 30 = (20 + 15)a$
$166 = 35a$
$a = 4.74 \frac{m}{s^2}$



$F_g = mg$
$F_g = 15 \times 9.8$
$F_g = 147\ N$

Mass 2

$F = ma$
$T_2 - F_f = ma$
$T_2 = ma + F_f$
$T_2 = 15 \times 4.74 + 30$
$T_2 = 101.2\ N$



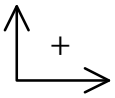
$F_g = mg$
$F_g = 20 \times 9.8$
$F_g = 196\ N$

Mass 1

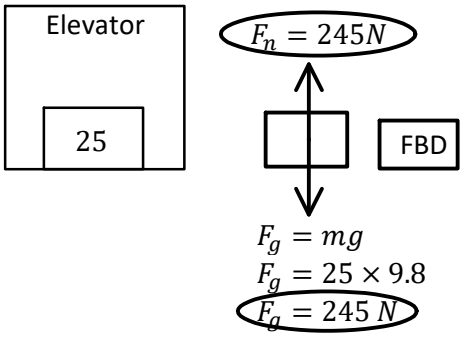
$F = ma$
$F_g - T_1 = ma$
$T_1 = F_g - ma$
$T_1 = 196 - 20 \times 4.74$
$T_1 = 101.2\ N$

P11 - 3.4 - Elevator Notes

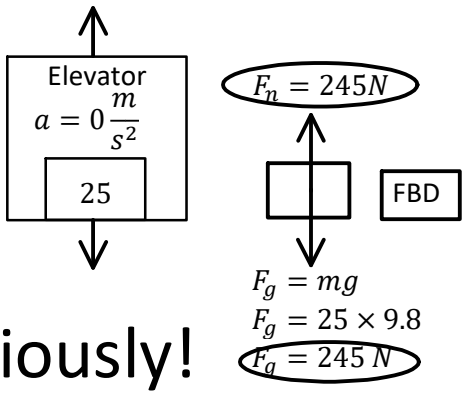
Logic



Find the weight of a 25 kg object on a scale in a stationary Elevator?

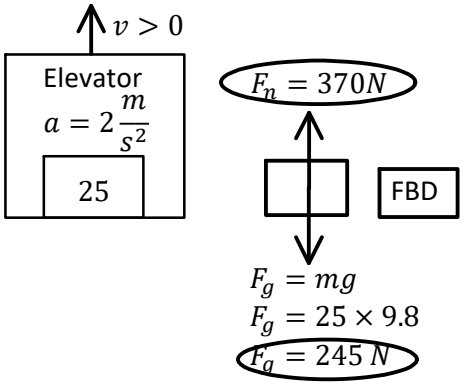


What is the weight of a 25 kg object on a scale in a Elevator moving at a constant velocity?



Obviously!

Find the weight of a 25 kg object on a scale in an Elevator moving up, $a = 5\frac{m}{s^2}$ upwards.



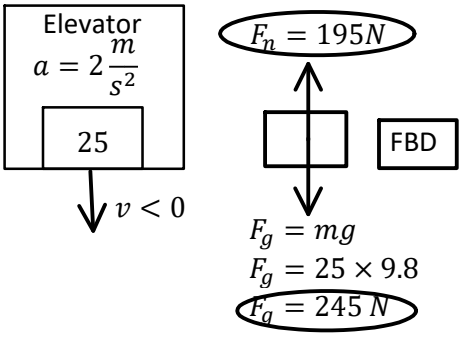
$$F_{net} = ma$$
$$F_n - F_g = ma$$
$$F_n = ma + F_g$$
$$F_n - 245 = (25)(5) + 245$$
$$F_n = 370\ N$$

Obviously you would be Heavier

Or going up slowing down

Obviously!

Find the weight of a 25 kg object on a scale in an Elevator moving down, $a = 2\frac{m}{s^2}$ downward.



$$F_{net} = ma$$
$$F_g - F_n = ma$$
$$F_n = F_g - ma$$
$$F_n = 245 - (25)(2)$$
$$F_n = 195\ N$$

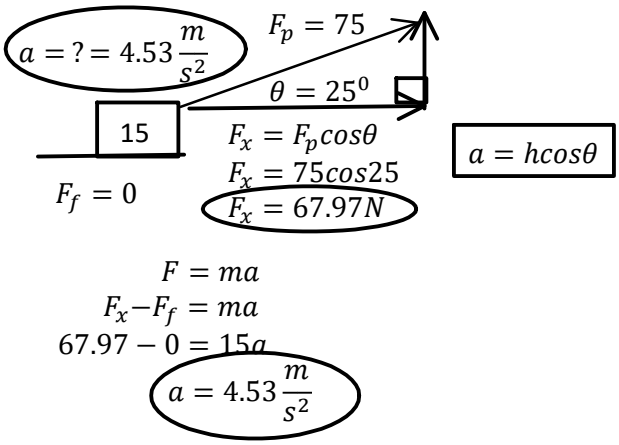
Obviously you would be Lighter

Or going down speeding up

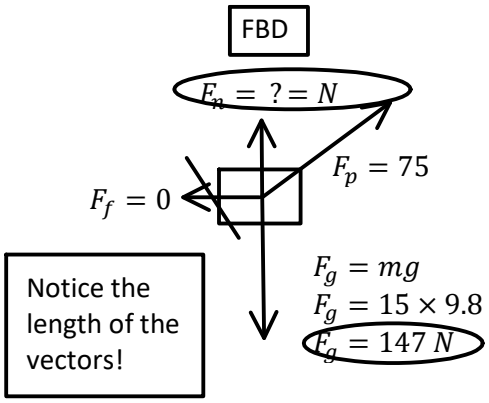
Obviously!

P12 - 3.5 - Dynamics Trig Notes

Find the acceleration of a $F = 75\ N$ *on a* $15kg$ *object pulled at an angle of* 25^0 *in diagram?*

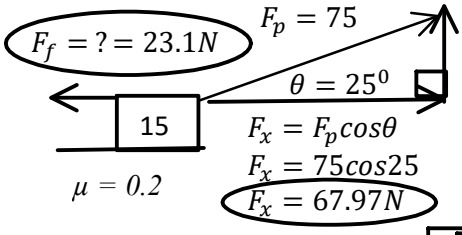


$$F = ma$$
$$F_x - F_f = ma$$
$$67.97 - 0 = 15a$$
$$a = 4.53\frac{m}{s^2}$$



Find the "a" of a $F = 75\ N$ *on a* $15kg$ *object pulled at an angke of* 25^0 *and* $\mu = 0.2$*? in diagram.*

$a = ? =$



$F_y = F_p sin\theta$
$F_y = 75sin25$
$F_y = 31.69$

$o = hsin\theta$

$$F = ma$$
$$F_x - F_f = ma$$
$$67.97 - 23.06 = 15a$$
$$a = 2.99\frac{m}{s^2}$$

Isolate 1st

$$F = ma$$
$$F_x - F_f = ma$$
$$a = \frac{F_x - F_f}{m}$$
$$a = \frac{67.97 - 23.06}{15}$$
$$a = 2.99\frac{m}{s^2}$$

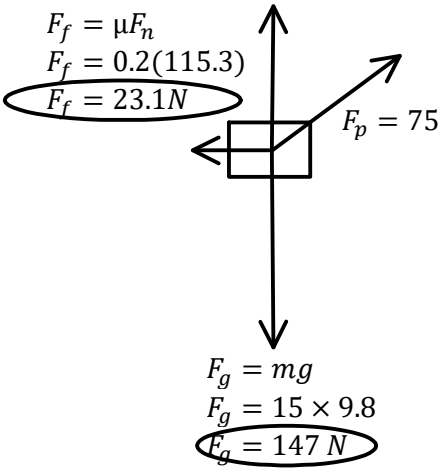
Kind of Pointless

Logic

FBD

$F_n = mg - F_y$
$F_n = 147 - 31.69$
$F_n = 115.3$

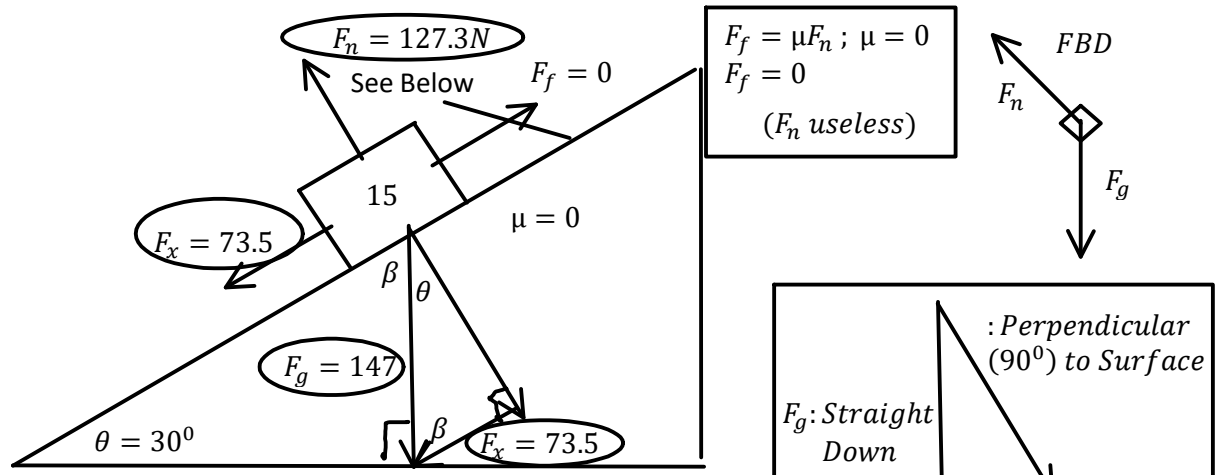
$F_f = \mu F_n$
$F_f = 0.2(115.3)$
$F_f = 23.1N$



What takes less force to pull or push a lawn mower? Pull, because pushing loses force to the ground!

P12 - 3.6 - Dynamics Fric Slope Notes

What is the acceleration of a 15 *kg block sliding down a* 30^0*slope? Ignore Friction.*

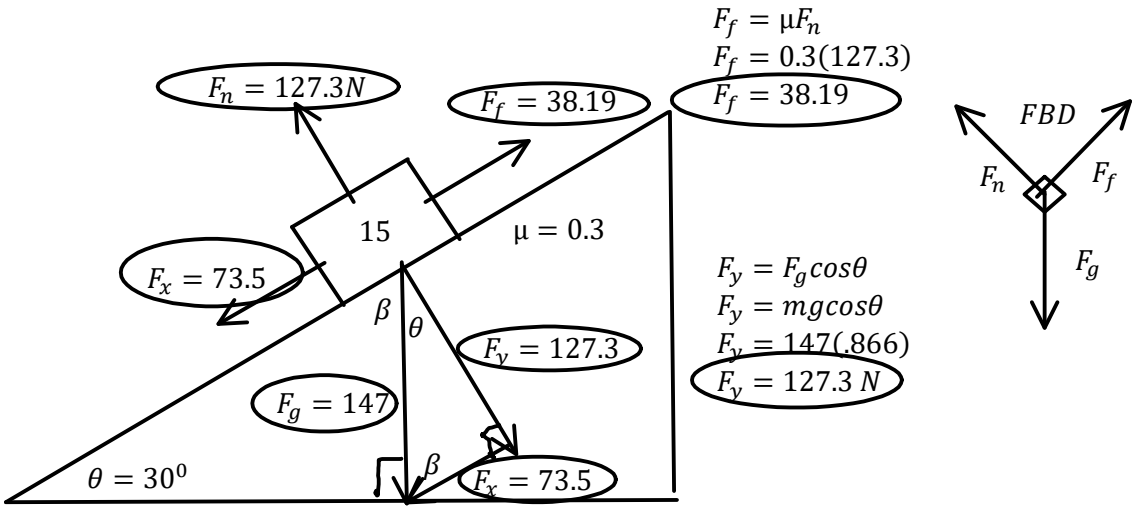


$F_g = mg$
$F_g = 15(9.8)$
$F_g = 147$

$F_x = F_g sin\theta$
$F_x = mgsin30$
$F_x = 147(.5)$
$F_x = 73.5$

$F = ma$
$F_x - F_f = ma$
$73.5 - 0 = 15a$
$a = 4.9 \frac{m}{s^2}$

What is the acceleration of a 15 *kg block sliding down a* 30^0*slope with* $\mu = 0.3$.

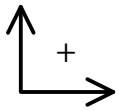


$F_g = mg$
$F_g = 15(9.8)$
$F_g = 147$

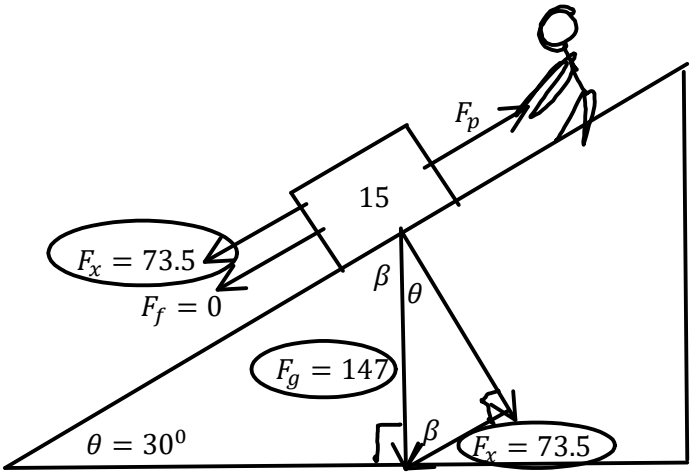
$F_x = F_g sin\theta$
$F_x = mgsin30$
$F_x = 147(.5)$
$F_x = 73.5$

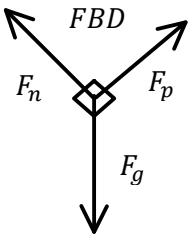
$F = ma$
$F_x - F_f = ma$
$73.5 - 38.19 = 15a$
$a = 2.35 \frac{m}{s^2}$

P12 - 3.6 - Dynamics Pull Fric Slope Notes



How much force is required to accelerate a 15 *kg object at* $2\frac{m}{s^2}$ *up a slope* 30^0 *with* $\mu = 0$?



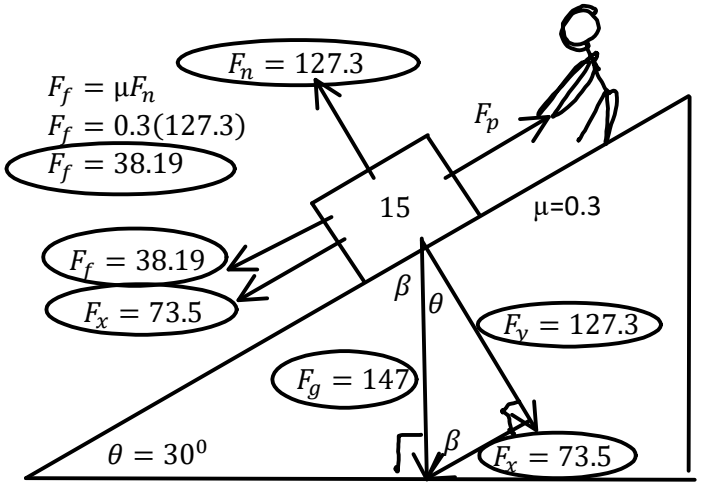


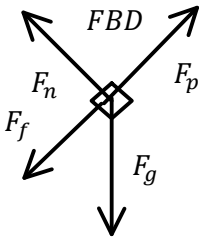
$F_g = mg$
$F_g = 15(9.8)$
$F_g = 147$

$F_x = F_g sin\theta$
$F_x = mgsin30$
$F_x = 147(.5)$
$F_x = 73.5$

$F = ma$
$F_p - F_x - F_f = ma$
$F_p - 73.5 = 15(2)$
$F_p = 103.5\ N$

How much force is required to accelerate a 15 *kg object at* $2\frac{m}{s^2}$ *up a slope* 30^0 *with* $\mu = 0.3$?





$F_y = F_g cos\theta$
$F_y = mgcos\theta$
$F_y = 147(.866)$
$F_y = 127.3\ N$

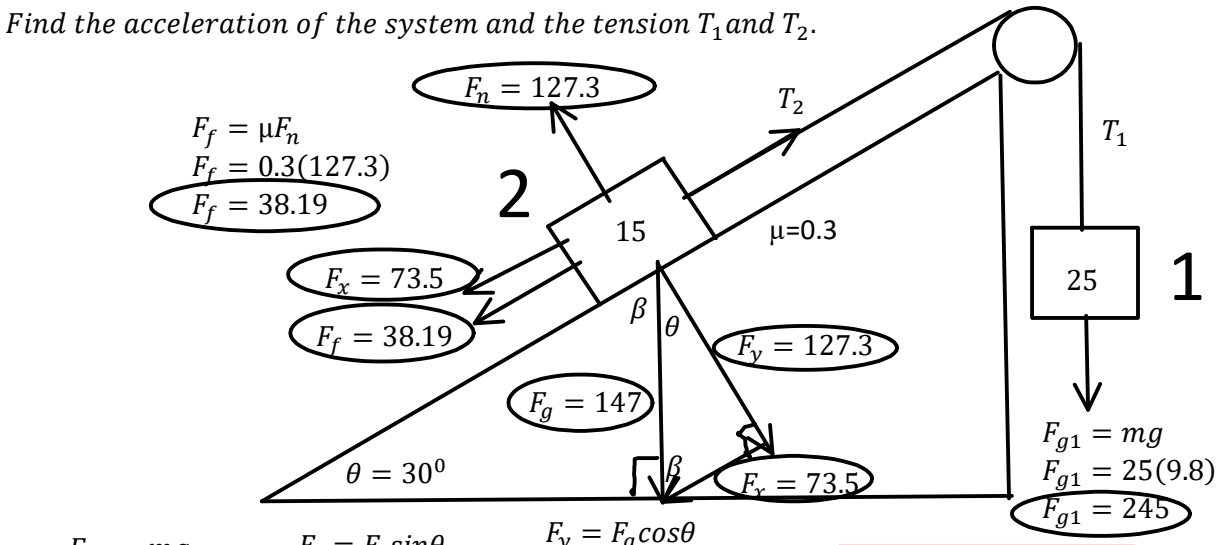
$F_g = mg$
$F_g = 15(9.8)$
$F_g = 147$

$F_x = F_g sin\theta$
$F_x = mgsin30$
$F_x = 147(.5)$
$F_x = 73.5$

$F = ma$
$F_p - F_x - F_f = ma$
$F_p - 73.5 - 38.19 = 15(2)$
$F_p = 141.69\ N$

P12 - 3.6 - Dynamics Pulley Fric Up Slope Notes

Find the acceleration of the system and the tension T_1 and T_2.



$F_{g2} = mg$
$F_{g2} = 15(9.8)$
$F_{g2} = 147$

$F_x = F_g sin\theta$
$F_x = mgsin30$
$F_x = 147(.5)$
$F_x = 73.5$

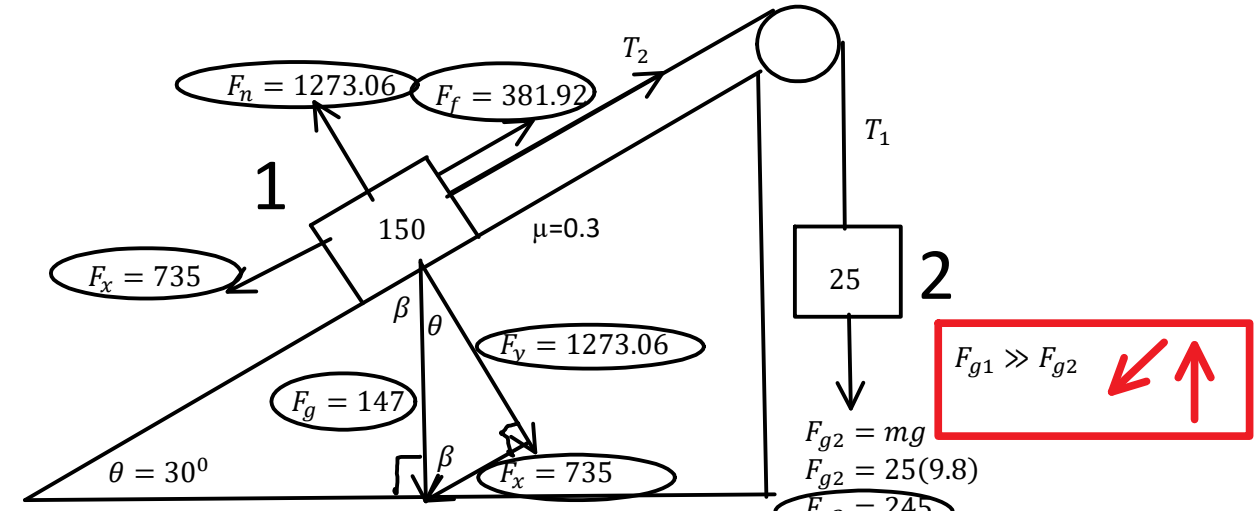
$F_y = F_g cos\theta$
$F_y = mgcos\theta$
$F_y = 147(.866)$
$F_y = 127.3\ N$

$F_{g1} > F_{g2}$

$F = ma$
$F_{g1} - T_1 + T_2 - F_x - F_f = ma$
$245 - 73.5 - 38.19 = 40a$
$a = 3.3\frac{m}{s^2}$

Mass 2
$F = ma$
$T_2 - F_x - F_f = ma$
$T_2 - 73.5 - 38.19 = 15 \times 3.3$
$T_2 = 161.19\ N$

Mass 1
$F = ma$
$Fg - T_1 = ma$
$245 - T_1 = 25 \times 3.3$
$T_1 = 162.5\ N$



$F_{g1} \gg F_{g2}$

$F_{g1} = mg$
$F_{g1} = 150(9.8)$
$F_{g1} = 1470$

$F_x = F_g sin\theta$
$F_x = mgsin30$
$F_x = 1470(.5)$
$F_x = 735$

$F_y = F_g cos\theta$
$F_y = mgcos\theta$
$F_y = 1470(.866)$
$F_y = 1273.06\ N$

$F_f = \mu F_n$
$F_f = 0.3(1273.06)$
$F_f = 381.92$

$F = ma$
$F_x - F_f - T_2 + T_1 - F_{g2} = ma$
$735 - 381.92 - 245 = 40a$
$F_p = 2.7\ N$

Mass 1
$F = ma$
$F_x - F_f - T_2 = ma$
$735 - 381.92 - T_2 = 15(2.7)$
$T_2 = 313.5\ N$

Mass 2
$F = ma$
$T_2 - F_g = ma$
$T_2 - 245 = 25(2.7)$
$T_1 = 312.5\ N$