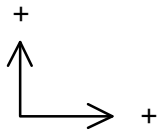
P11 - 3.1 - Dynamics Definitions Notes



Force - A Push or pull Units: Newton's (N)

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

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

Four Fundamental Forces

1. **<u>Gravitational P11</u>**
2. Electromagnetic P12
3. Strong Nuclear C12 (keeps p^+ in nucleus)
4. Weak Nuclear C12 (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

$$Weight = F_n = mg$$

$$a = 0$$

The Gravitational Force:

$$F_g = mg$$

$F_g: Force\ of\ Gravity$ $m: Mass$ $g: Gravitational\ Constant$

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

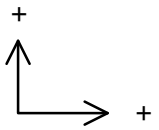
$$\frac{N}{kg} = \frac{m}{s^2}$$

Mass is **<u>constant</u>** throughout the universe.
Weight **<u>depends</u>** on your location. (Earth, Moon, Space, etc)

g, depends on the planet and distance from it's centre

$$g = -9.8\frac{m}{s^2}\ (Earth)$$
$$g = -1.6\frac{m}{s^2}\ (Moon)$$
$$g = -274\frac{m}{s^2}\ (Sun)$$

P11 - 3.2 - $F = ma$ Newton's Laws Notes



Newton's 3 Laws:

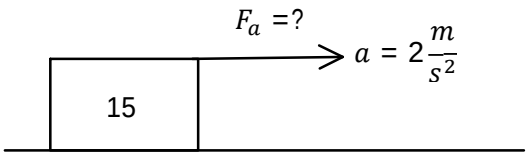
$F = ma$ The sum of the forces in the direction of motion, (minus opposing forces.) (Winners minus losers.)
Tug of War

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

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

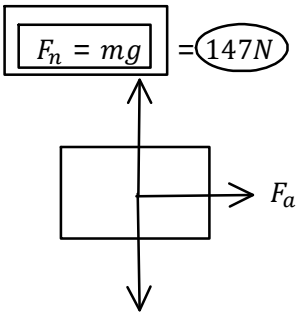
What is the Force required to accelerated a $15kg$ *object at* $2\frac{m}{s^2}$?

$m = 15kg$



F_a = *Applied Force*
F_g = *Gravitational Force*
F_n = *Normal Force*

Free Body Diagram: FBD



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

$F = ma$

$F = F_{net}$

$F_g = mg$

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

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

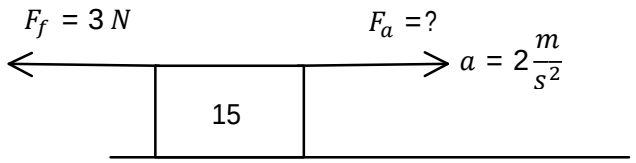
$F_{net} = ma$
$F_a - F_f = ma$
$F_a - 0 = 15 \times 2$
$F_a = 30\ N$

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

$F_{net} = ma$
$F_a - F_f = ma$

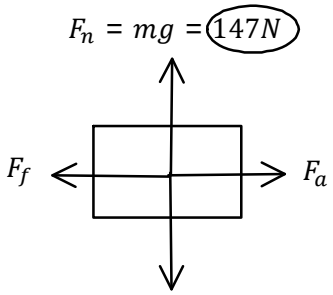
$F_{net} = F_a - F_f$

What is the Force required to Accelerated a $15kg$ *object at* $2\frac{m}{s^2}$, *with a Frictional Force of* 3 *Newton's* ?



F_f = *Frictional Force*

FBD



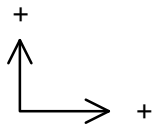
$F = ma$
$F_a - F_f = ma$
$F_a - 3 = 15 \times 2$
$F_a = 33\ N$

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

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

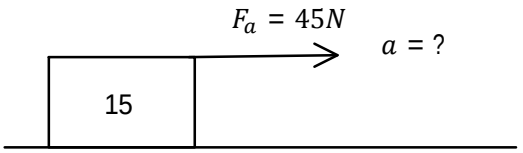
$F_n = F_g$ On ground, only Gravitational Force Acting on it Vertically.

P11 - 3.2 - $F = ma$ Solve Variable Notes



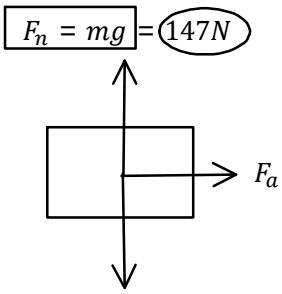
A Force of 45 *N is applied to a* 15*kg object. Find its acceleration.*

$m = 15kg$



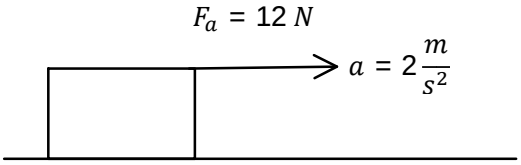
$F = ma$
$45 = (15)a$
$a = 3\ N$

FBD



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

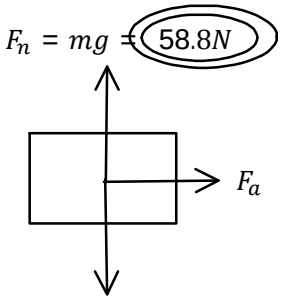
A Force of 12 *N Accelerates an object at* $2\frac{m}{s^2}$, *What is the Mass of the object?*
What is the objects Weight?



$F = ma$
$12 = m(2)$
$12 = 2m$
$m = 6\ kg$

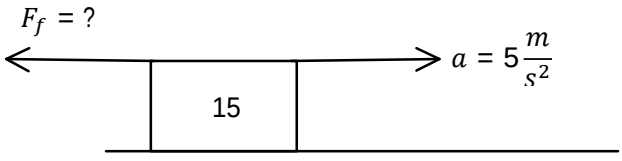
$Weight = F_n$

FBD



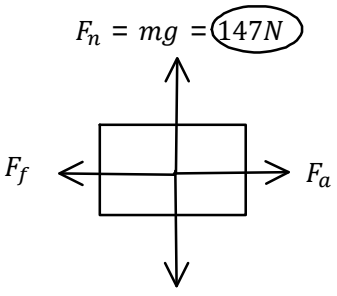
$F_g = mg$
$F_g = 6 \times 9.8$
$F_g = 58.8\ N$

A Applied Force of 92 *N on a* 15 *kg object Accelerates it at* $5\frac{m}{s^2}$. *What is the Frictional Force?*



$F = ma$
$F_a - F_f = ma$
$92 - F_f = 15 \times 5$
$92 - F_f = 75$
$F_f = 17\ N$

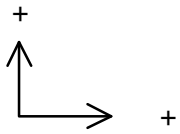
FBD



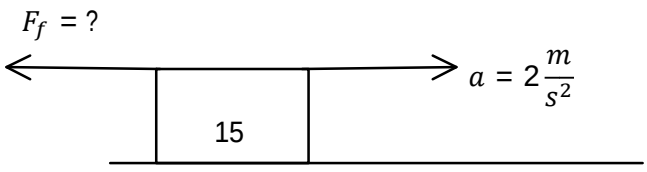
$F_g = mg$
$F_g = 15 \times 9.8$
$F_g = 147\ N$

And all the other combinations of doing Algebra to solve for Variables. M10.

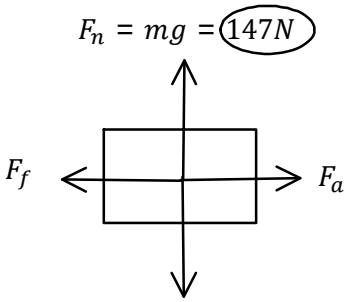
P11 - 3.3 - $F_f = \mu F_n$ Dynamics



What is the Force required to Accelerated a $15kg$ *object at* $2\frac{m}{s^2}$, *with a Frictional Co − efficint of* 0.3?



FBD



$\mu = 0.3$ μ : Frictional Co – efficient (Mhew) No Units.

$F_f = \mu F_n$
$F_f = 0.3 \times 147$
$F_f = 44.1\ N$

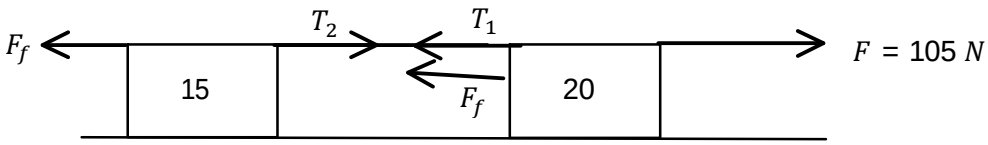
$$\boxed{F_f = \mu F_n}$$

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

$F = ma$
$F_a - F_f = ma$
$F_a - 44.1 = 15 \times 2$
$F_a = 74.1\ N$

Higher the Mhew, μ, Higher the Frictional Force.

P11 - 3.4 - Tension Notes



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

No Friction
$T_1 = T_2$
Mass of system

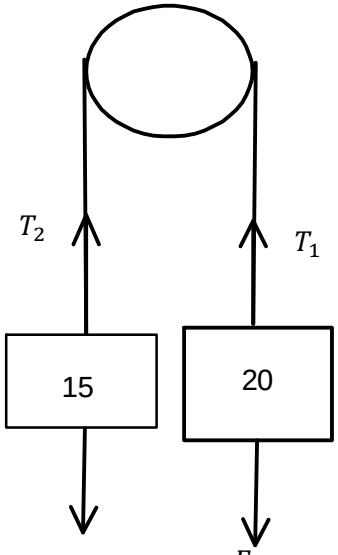
Mass 1

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

Mass 2

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

Tension should be equal



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

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

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

$T_1 = T_2$
Mass of system

Mass 1

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

Mass 2

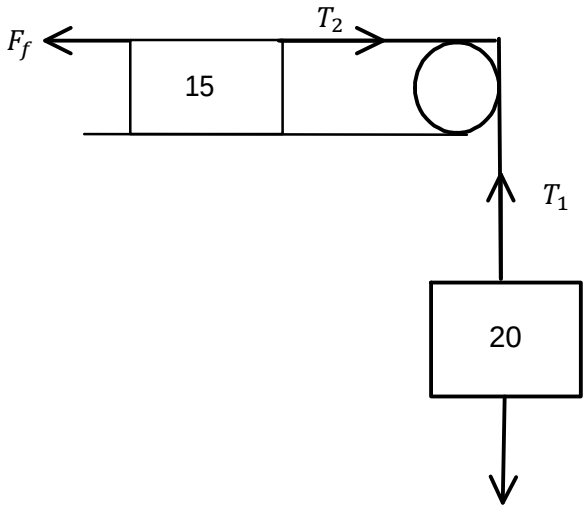
$$F = ma$$
$$T_2 - F_f = ma$$
$$T_2 - 0 = 15 \times 3$$
$$T_2 = 45\ N$$

Tension should be equal

P11 - 3.4 - Tension Notes

Atwood/flat/slope

+ ↓



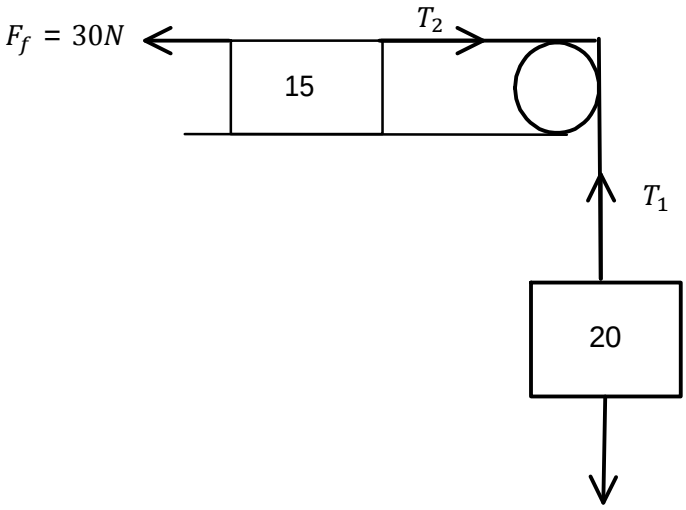
$Fg = mg$
$Fg = 20(9.8)$
$Fg = 196\ N$

$F = ma$
$Fg_1 - T_1 + T_2 - F_f = ma$
$196\ N = (20 + 15)a$
$196 = 35a$
$a = 5.6\frac{m}{s^2}$

No Friction
$T_1 = T_2$
Mass of system

Mass 1	*Mass* 2
$F = ma$	$F = ma$
$Fg - T_1 = ma$	$T_2 - F_f = ma$
$196 - T_1 = 20 \times 5.6$	$T_2 = 15 \times 5.6$
$T_1 = 84\ N$	$T_2 = 84\ N$

Tension should be equal



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

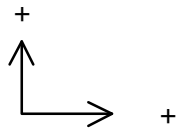
$F = ma$
$Fg_1 - T_1 + T_2 - F_f = ma$
$196 - 30 = (20 + 15)a$
$166 = 35a$
$a = 4.74\frac{m}{s^2}$

$T_1 = T_2$
Mass of system

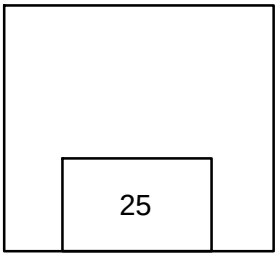
Mass 1	*Mass* 2
$F = ma$	$F = ma$
$Fg - T_1 = ma$	$T_2 - F_f = ma$
$196 - T_1 = 20 \times 4.74$	$T_2 - 30 = 15 \times 4.74$
$T_1 = 101.2\ N$	$T_2 = 101.1\ N$

Tension should be equal

P11 - 3.5 - Elevator Notes

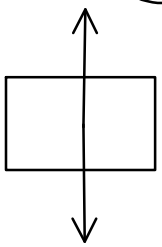


What is the weight of a 25 *kg object on a scale (in Newton's) in a stationary Elevator?*



$F_n = mg$
$F_n = 25 \times 9.8$
$F_n = 245\ N$

$F_n = mg = 245N$



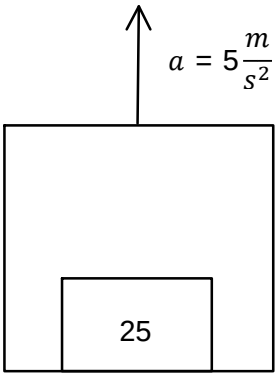
$F_g = mg$
$F_g = 25 \times 9.8$
$F_g = 245\ N$

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

$F_n = mg$
$F_n = 25 \times 9.8$
$F_n = 245\ N$

$a = 0\frac{m}{s^2}$

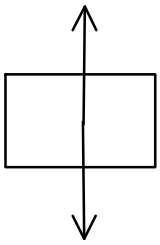
What is the weight of a 25 *kg object on a scale in an Elevator accelerating upwards at* $5\frac{m}{s^2}$.?



$F_{net} = ma$
$F_n - F_g = ma$
$F_n - 245 = (25)(5)$
$F_n - 245 = 125$
$F_n = 370\ N$

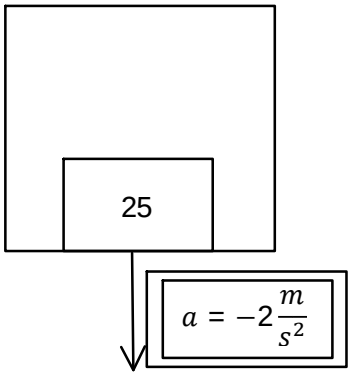
Obviously you would be Heavier

F_n



$F_g = mg$
$F_g = 25 \times 9.8$
$F_g = 245\ N$

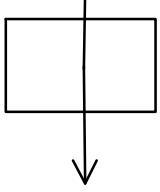
What is the weight of a 25 *kg object on a scale in an Elevator accelerating downward at* $2\frac{m}{s^2}$.?



$F_{net} = ma$
$F_n - F_g = ma$
$F_n - 245 = (25)(-2)$
$F_n - 245 = -50$
$F_n = 195\ N$

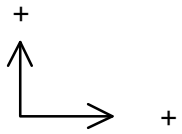
Obviously you would be Lighter.

F_n



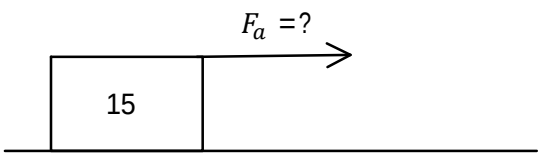
$F_g = mg$
$F_g = 15 \times 9.8$
$F_g = 245\ N$

P11 - 3.6 - Kinematics Dynamics Link Notes



What is the Force required to accelerate a 15 *kg object from rest to* $25\frac{m}{s}$ *in* 5 *seconds?*

$v_i = 0$



$F = ma$
$F = 15a$

$F = (15)(5)$
$F = 75N$

$v_f = v_i + at$
$25 = 0 + a(5)$
$25 = 5a$
$a = 5\frac{m}{s^2}$

Acceleration is the Kinematics - Dynamics Link

How far did the object go?

$\Delta d = v_i t + \frac{1}{2}at^2$
$d = (0)t + \frac{1}{2}(25)(5)^2$
$d = 1250\,m$

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 $25\frac{m}{s}$.

$v_f = v_i + at$
$25 = 0 + 5t$
$t = 5s$

P11 - 3.7 - Gravitational Force F_g Notes

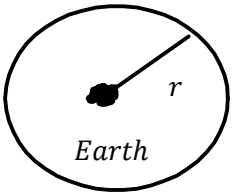
F_g: *The Gravitational Force between any two Objects anywhere in the Universe.* (*Newton*)

What is the Gravitational Force, F_g, *on a* $1kg$ *Object on Earth?*

$$F_g = \frac{Gm_1m_2}{r^2}$$
$$F_g = \frac{((6.67 \times 10^{-11})(1)(5.98 \times 10^{24}))}{((6.38 \times 10^6)^2)}$$

$F_g = 9.79\ N$

Mass of Earth:	$5.98 \times 10^{24} kg$
Radius of Earth:	$6.38 \times 10^6 m$



Look similar to Gravity. Newton!

$f_g = mg$
$f_g = 1 \times 9.8$

$f_g = 9.8\ N$

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

What is the Gravitational Force, F_g, *on a* 100 kg *Object on Earth?*

$$F_g = \frac{Gm_1m_2}{r^2}$$
$$F_g = \frac{((6.67 \times 10^{-11})(100)(5.98 \times 10^{24}))}{((6.38 \times 10^6)^2)}$$

$F_g = 979.91\ N$

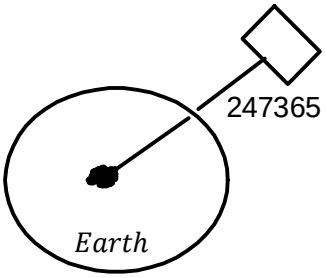
$f_g = mg$
$f_g = 100 \times 9.8$

$f_g = 980\ N$

What is the Gravitational Force, F_g, *on a* 12345 kg *Satelite* 247365 m *above Earth Surface?*

$$F_g = \frac{Gm_1m_2}{r^2}$$
$$F_g = \frac{((6.67 \times 10^{-11})(12335)(5.98 \times 10^{24}))}{((6627365)^2)}$$
$F_g = 112107.93\ N$

$F_g = 1.12 \times 10^5\ N$



$r = 6.38 \times 10^6 + 247365$

$r = 6627365\ m$

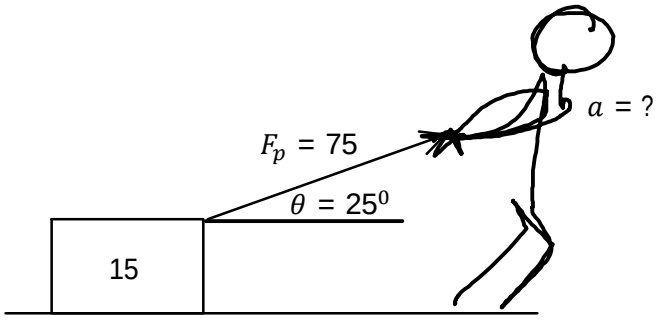
What is the Gravitational Force, F_g, *between twins of* $50kg$ 5 m *apart?*

$$F_g = \frac{Gm_1m_2}{r^2}$$
$$F_g = \frac{((6.67 \times 10^{-11})(50)(50))}{((5)^2)}$$

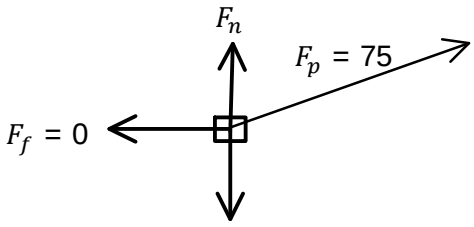
$F_g = 6.67 \times 10^{-9}\ N$

P12 - 3.8 - Dynamics Trig Notes

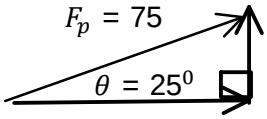
Find the acceleration of A Force of 75 *N on a* 15*kg object pulled at an angle of* 25^0 *above the horizontal? Ignore Friction.*



FBD



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



$F_x = F_p cos\theta$
$F_x = 75cos25$
$F_x = 67.97$

$a = hcos\theta$

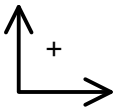
$F = ma$
$F_x - F_f = ma$
$67.97 - 0 = 15a$

$a = 4.53 \frac{m}{s^2}$

Isolate 1st

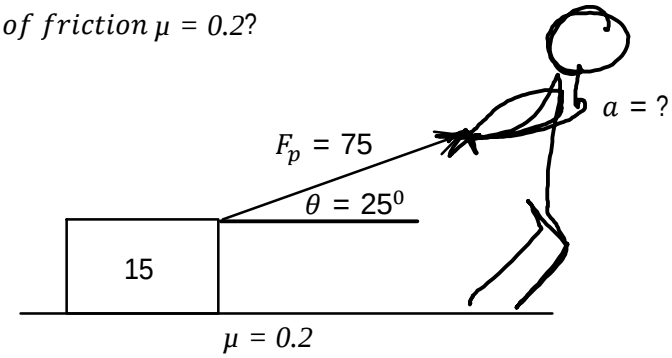
$F = ma$
$F_x - F_f = ma$
$a = \frac{F_x}{m}$
$a = \frac{67.97}{15}$
$a = 4.53 \frac{m}{s^2}$

P12 - 3.8 - Dynamics Fric Trig Notes



Find the acceleration of A Force of 75 *N on a* 15*kg object pulled at an angke of* 25^0 *to te horizontal,*

With a coefficient of friction $\mu = 0.2$?



FBD

$F_n + F_y = F_g$

$F_n = mg - F_y$

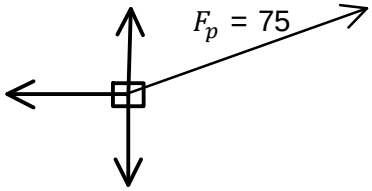
$F_n = 147 - 31.69$

$F_n = 115.3$

$F_f = \mu F_n$

$F_f = 0.2(115.3)$

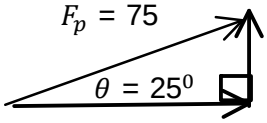
$F_f = 23.06$



$F_g = mg$

$F_g = 15 \times 9.8$

$F_g = 147\ N$



$F_y = F_p sin\theta$

$F_y = 75sin25$

$F_y = 31.69$

$o = hsin\theta$

$F_x = F_p cos\theta$

$F_x = 75cos25$

$F_x = 67.97$

$F = ma$

$F_x - F_f = ma$

$67.97 - 23.06 = 15a$

$a = 2.99 \frac{m}{s^2}$

Isolate 1st

$F = ma$

$F_x - F_f = ma$

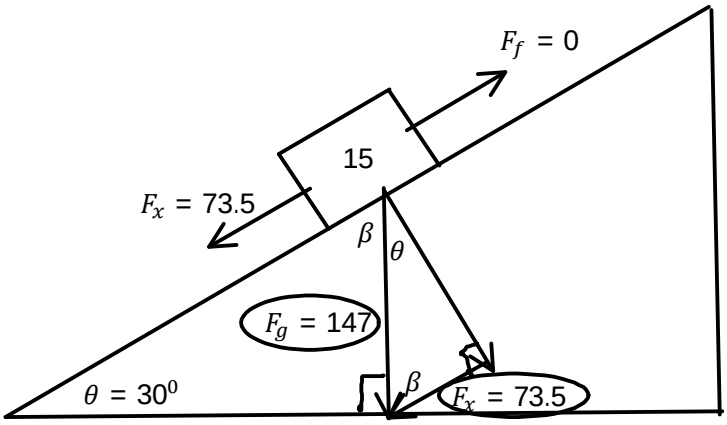
$a = \frac{F_x - F_f}{m}$

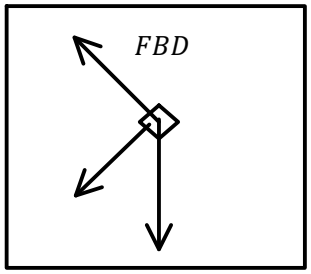
$a = \frac{67.97 - 23.06}{15}$

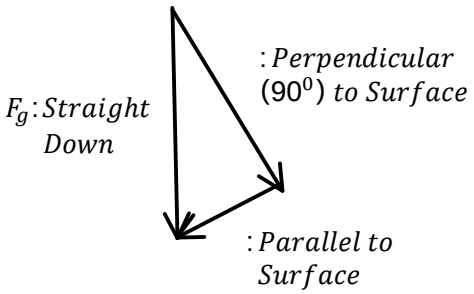
$a = 2.99 \frac{m}{s^2}$

P12 - 3.9 - Dynamics Fric Slope Notes

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





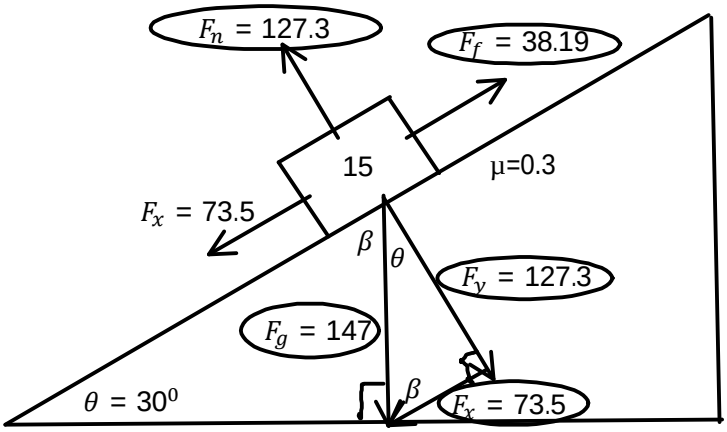


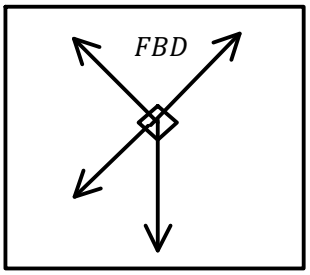
$F_g = mg$
F_g = 15(9.8)
F_g = 147

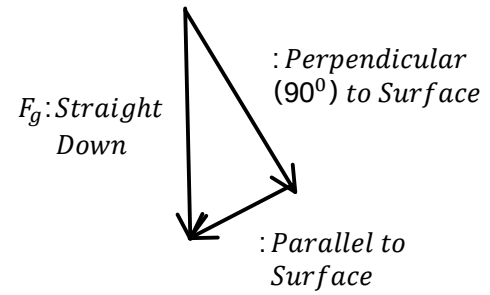
$F_x = F_g sin\theta$
$F_x = mgsin30$
F_x = 147(.5)
F_x = 73.5

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

What is the acceleration of a block sliding down a 30^0 *slope with a coefficient of Friction of* μ = 0.3.







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

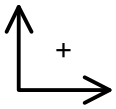
$F_x = F_g sin\theta$
$F_x = mgsin30$
F_x = 147(.5)
F_x = 73.5

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

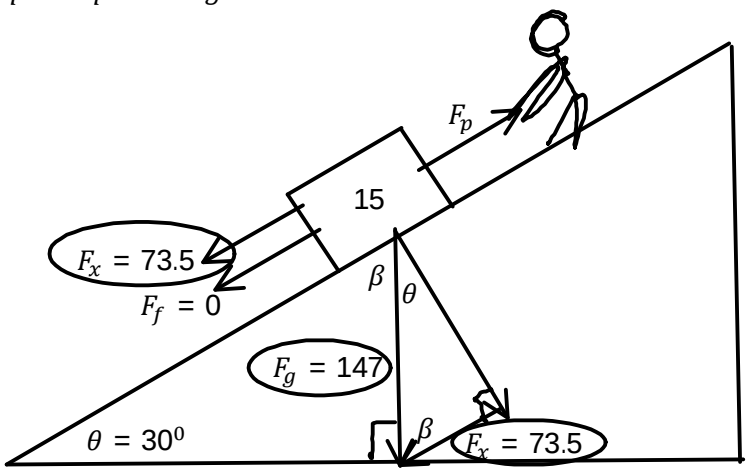
$F_f = \mu F_n$
F_f = 0.3(127.3)
F_f = 38.19

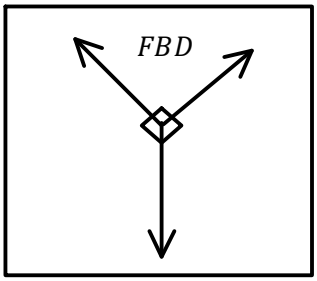
$F = ma$
$F_x - F_f = ma$
73.5 − 38.19 = 15a
$a = 2.35 \frac{m}{s^2}$

P12 - 3.9 - 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? *Ignore Friction.*





F_g: *Straight Down*

: *Perpendicular* (90^0) *to Surface*

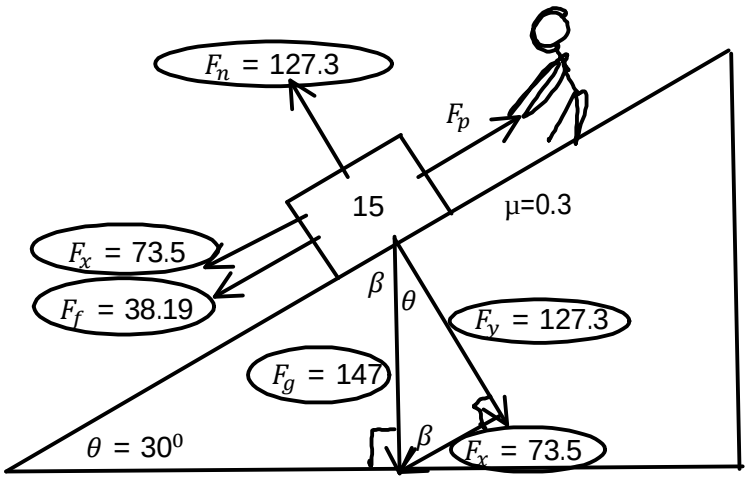
: *Parallel to Surface*

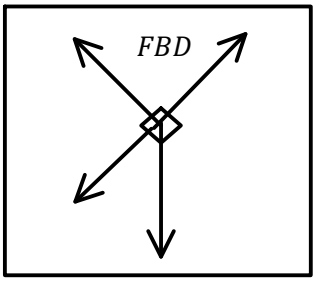
$F_g = mg$
F_g = 15(9.8)
F_g = 147

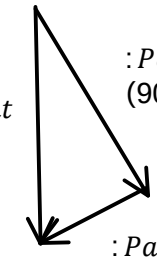
$F_x = F_g sin\theta$
$F_x = mgsin30$
F_x = 147(.5)
F_x = 73.5

$F = ma$
$F_p - F_x - F_f = ma$
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 a coefficient of Friction of* μ = 0.3.?







F_g: *Straight Down*

: *Perpendicular* (90^0) *to Surface*

: *Parallel to Surface*

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

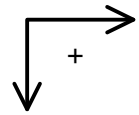
$F_x = F_g sin\theta$
$F_x = mgsin30$
F_x = 147(.5)
F_x = 73.5

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

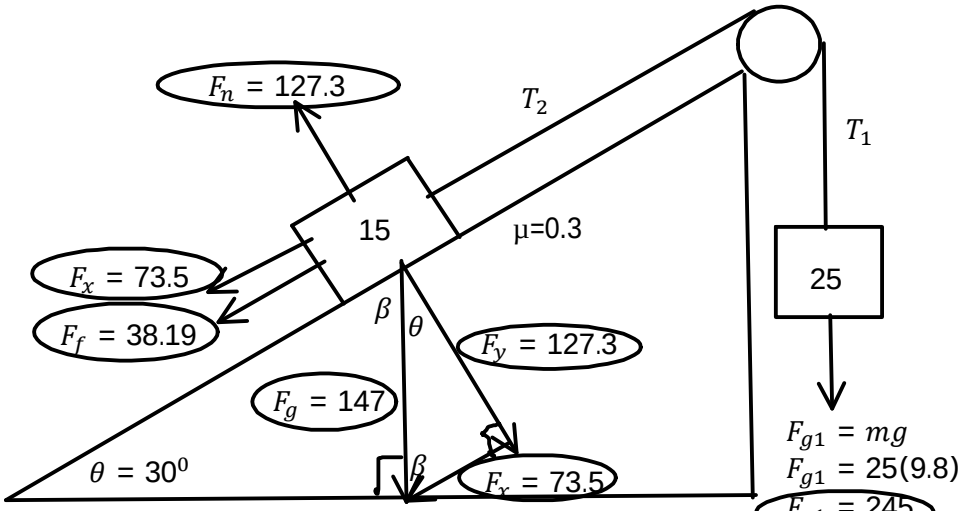
$F_f = \mu F_n$
F_f = 0.3(127.3)
F_f = 38.19

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

P12 - 3.9 - 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_x = 147(.866)
F_y = 127.3 N

F_f = μF_n
F_f = 0.3(127.3)
F_f = 38.19

$F = ma$
$F_{g1} - T_1 + T_2 - F_x - F_f = ma$
245 − 73.5 − 38.19 = 40a
F_p = 3.3 N

Mass 1
$F = ma$
$Fg - T_1 = ma$
245 − T_1 = 25 × 3.3
T_1 = 162.5 N

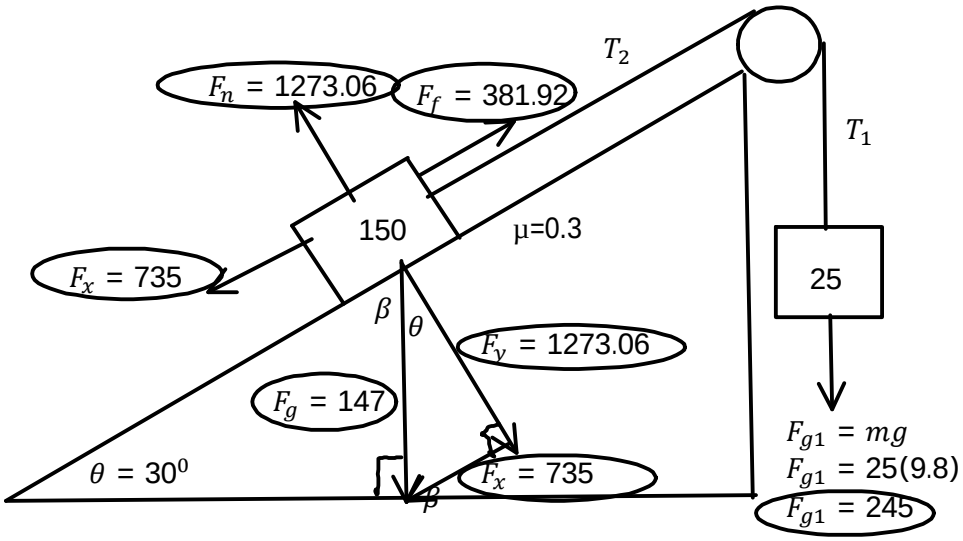
Mass 2
$F = ma$
$T_2 - F_x - F_f = ma$
T_2 − 73.5 − 38.19 = 15 × 3.3
T_2 = 161.19 N

Tension should be equal

P12 - 3.9 - Dynamics Pulley Fric Down Slope Notes

+

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



$F_{g2} = mg$
F_{g2} = 150(9.8)
F_{g2} = 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

$F = ma$
$F_{g1} - T_1 + T_2 + F_f - F_x = ma$
245 + 381.92 − 735 = 40a
$F_p = -2.7\ N$

Mass 1

$F = ma$
$Fg - T_1 = ma$
245 − T_1 = 25(−2.7)
T_1 = 312.5 N

Mass 2

$F = ma$
$T_2 + F_x - F_f = ma$
T_2 + 381.92 − 735 = 15(−2.7)
T_2 = 313.5 N

Tension should be equal