

STEP 1: Go to the **Homework Service**
at the URL <https://hw.utexas.edu/>

Select the link

Register yourself in your class

Unique course number: 21178

STEP 2: Return to <https://hw.utexas.edu/>

Download: **Students' Instructions**

Download: **Homework 1, 2, 3**

Ignore 1 and 2, but #3 is real !!

STEP 3: Work one question and submit its answer before the next class period.

STEP 4: Continue submitting answers until due time.

STEP 5: Download solutions after due time.



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<http://www.uta.edu/physics/courses/wkim/>

Or you can find me in 'People' section of Physics home page

Hint for 1st exam.

1. Work on the examples in the textbook.
2. Quiz is still helpful.
3. Homework will be great to practice by yourselves.
4. Scientific/Engineering calculator are not allowed.



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PHYS 1443

<http://www.uta.edu/physics/courses/wkim/>

Or you can find me in 'People' section of Physics home page

Ch. 5 Applications of Newton's Laws

Part of Ch. 4

Forces of Friction

Uniform and Non-uniform Circular Motions

Resistive Forces and Terminal Velocity



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Few useful formula

Newton's equation

$$\sum F_i = ma \quad \text{or} \quad F = ma$$

→ Relation between Force/mass/acceleration

Equation of Motion

$$x_f = x_i + v_i t + \frac{1}{2} a t^2 \quad a = \frac{dv}{dt} = \frac{d}{dt} \left(\frac{dx}{dt} \right) = \frac{d^2 x}{dt^2}$$

$$v_f = v_i + at \quad v_f^2 - v_i^2 = 2a\Delta x$$

Keep in mind....

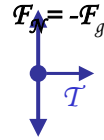
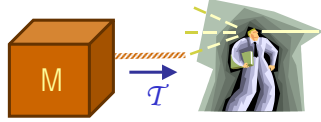
you are dealing with **Vector** !!



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Applications of Newton's Laws

Suppose you are pulling a box on frictionless ice, using a rope.

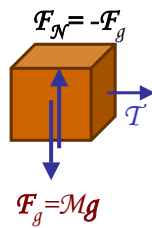


Free-body diagram

Gravitational force: F_g

Normal force: F_N

Tension force: T



$$F_N = -F_g$$

$$F_g = Mg$$

$$\text{Total force: } F = F_g + n + T = T$$

$$\sum F_x = T = Ma_x$$

$$\sum F_y = -F_g + n = Ma_y = 0$$

$$a_x = \frac{T}{M}$$

$$a_y = 0$$

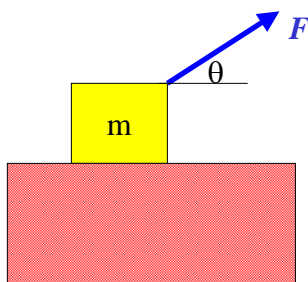
$$v_{xf} = v_{xi} + a_x t = v_{xi} + \left(\frac{T}{M}\right)t$$

$$\Delta x = x_f - x_i = v_{xi}t + \frac{1}{2}\left(\frac{T}{M}\right)t^2$$



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Calculate acceleration



$$\sum \vec{F} = m\vec{a}$$

Since, $a_y = 0$

$$\text{X-axis } \sum \vec{F}_x = m\vec{a}_x$$

$$F_x = F \cos \theta = ma_x$$

$$a_x = \frac{F}{m} \cos \theta$$

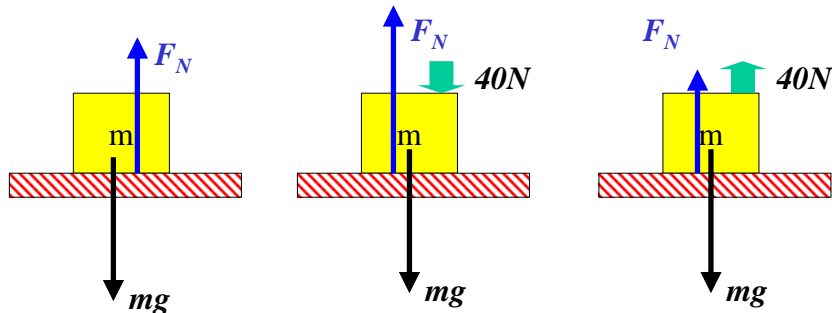
Now you can calculate v, x
...using equation of motion



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Calculate Normal Forces

Calculate (surface) normal forces F_N for the following cases.



$$|mg| = -|F_N|$$

$$|mg+40N| = -|F_N|$$

$$\sum \vec{F} = \vec{F}_N + m\vec{g} = ma = 0 \quad \sum \vec{F} = \vec{F}_N - m\vec{g} - 40N = 0$$

Since $a=0$

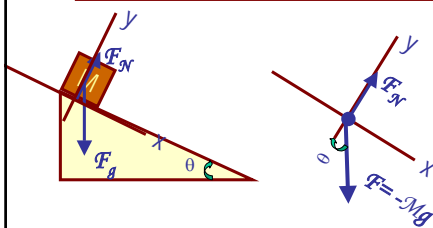


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Example 4.17 w/o Friction

A crate of mass M is placed on a frictionless inclined plane of angle θ .

a) Determine the acceleration of the crate after it is released.



$$\vec{F} = \vec{F}_g + \vec{F}_N = m\vec{a}$$

$$\text{X-axis } \sum F_x = Ma_x$$

$$\text{since, } F_{gx} = Mg \sin \theta$$

$$Mg \sin \theta = Ma_x$$

$$a_x = g \sin \theta$$

$$\text{y-axis } \sum F_y = Ma_y$$

$$\sum F_y = F_N - (Mg)_y = F_N - Mg \cos \theta$$

However, $a_y = 0$, since there isn't any motion along y-axis.

$$\sum F_y = 0 = F_N - Mg \cos \theta$$

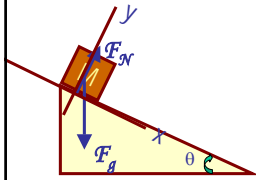
$$F_N = Mg \cos \theta$$



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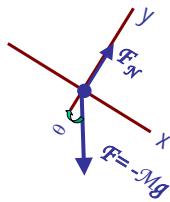
Example w/o Friction

Supposed the crate was released at the top of the incline, and the length of the incline is d . How long does it take for the crate to reach the bottom and what is its speed at the bottom?



$$\Delta x = d = v_{ix}t + \frac{1}{2}a_x t^2 = \frac{1}{2}g \sin \theta t^2$$

$$\therefore t = \sqrt{\frac{2d}{g \sin \theta}}$$



$$v_{xf} = v_{ix} + a_x t = g \sin \theta \sqrt{\frac{2d}{g \sin \theta}} = \sqrt{2dg \sin \theta}$$

$$\therefore v_{xf} = \sqrt{2dg \sin \theta}$$

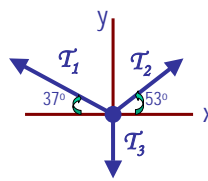
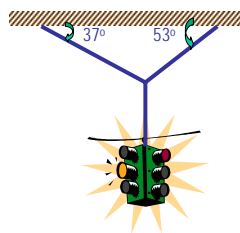
Or, you may use $v_f^2 - v_i^2 = 2as$



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Example for Using Newton's Laws

A traffic light weighing 125 N hangs from a cable tied to two other cables fastened to a support. The upper cables make angles of 37.0° and 53.0° with the horizontal. Find the tension in the three cables.



$$\vec{F} = \vec{T}_1 + \vec{T}_2 + \vec{T}_3 = m\vec{a} = 0 \quad \text{Newton's 2nd law}$$

x-comp. of net force $F_x = \sum_{i=1}^{i=3} T_{ix} = 0 \quad -T_1 \cos(37^\circ) + T_2 \cos(53^\circ) = 0 \therefore T_1 = \frac{\cos(53^\circ)}{\cos(37^\circ)} T_2 = 0.754T_2$

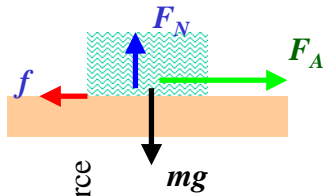
y-comp. of net force $F_y = \sum_{i=1}^{i=3} T_{iy} = 0 \quad T_1 \sin(37^\circ) + T_2 \sin(53^\circ) - mg = 0$
 $T_2 [\sin(53^\circ) + 0.754 \times \sin(37^\circ)] = 1.25T_2 = 125N$
 $T_2 = 100N; \quad T_1 = 0.754T_2 = 75.4N$



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Friction

Resistive force caused by the surfaces of the moving object.

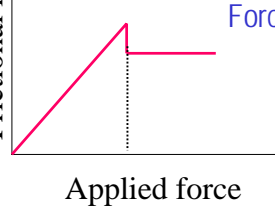


Force of static friction, f_s :

$$|\vec{f}_s| \leq \mu_s |\vec{F}_N|$$

$$\mu_{s, \max} > \mu_k$$

Frictional force



Force of kinetic friction, f_k

$$|\vec{f}_k| = \mu_k |\vec{F}_N|$$

$$|\vec{f}_k| \propto |\vec{F}_N|$$

