University of Manitoba — physics & astronomy

The Canadian Association of Physicists (CAP) and the Department of Physics and Astronomy, University of Manitoba, present a

Public/Undergraduate Lecture

Applying Quantum Entanglement to Search for New Physics at TeV Energies

Dr. J. Michael Roney
CAP Lecture Tour Speaker 2016
Institute of Particle Physics, and University of Victoria

FRIDAY, FEBRUARY 12 2015
3:30 pm, Room 205 Armes Building

There will be coffee served at 3:00pm in 205 Armes Building and time for discussion and snacks following the talk.

Recipe for the Application of Newton's Laws of Motion

If $\vec{F}_{net} = 0$ then $\Delta\vec{v} = 0$

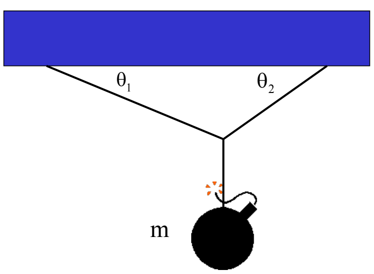
$\vec{F}_{net} = m\vec{a}$

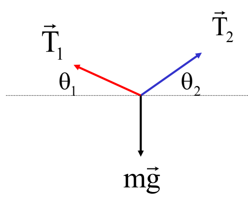
$\vec{F}_{AB} = -\vec{F}_{BA}$

1. Choose the system or component parts to be studied.
2. Make a simple sketch of the system (or its component parts).
   - Gather knowns
   - Take note of what the problem is asking for.
3. Choose a convenient coordinate system.
4. Draw a free-body diagram and identify all the forces that act on the system (or its parts).
5. Apply Newton's laws of motion to the system (or each part).
   - Set up a system of algebraic equations
   - Solve the system of equations.
   - Plug in any given values.

Example – Equilibrium

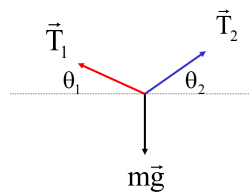
Object hanging by a thread.

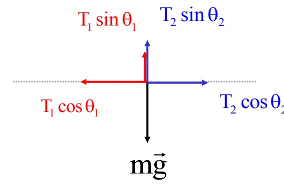




$$\sum \vec{F} = 0$$

Resolve into components



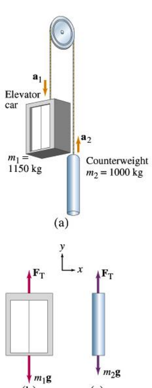


$$\sum F_x = 0 = -T_1\cos\theta_1 + T_2\cos\theta_2$$

$$\sum F_y = 0 = T_1\sin\theta_1 + T_2\sin\theta_2 - mg$$

Example

Atwood's machine (a pulley)



Object 1: Elevator Car

$$\sum F_y = F_T - m_1 g = m_1 a_1$$

Object 2: Counterweight

$$\sum F_y = F_T - m_2 g = m_2 a_2$$

Constraint: $a_1 = -a_2$

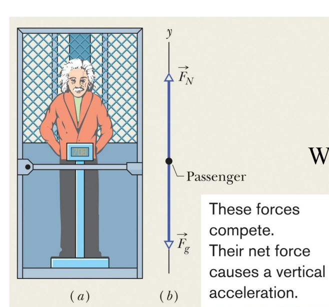
Example

Inside the elevator (non-inertial frame)

While moving up at constant velocity:

$$\sum F_y = F_N - mg = 0$$
$$\therefore F_N = mg$$

Scale reads correctly.



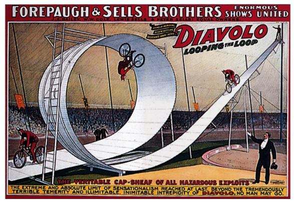
While slowing down ($a<0$):

$$\sum F_y = F_N - mg = ma < 0$$
$$\therefore F_N = m(g+a) < mg$$

Scale reads light!

Question

Which of the following statements about the forces on Diavolo at the top of the loop is true?



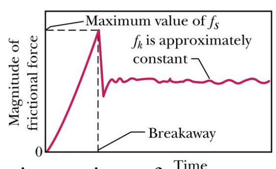
A. The net force is upwards, otherwise he would fall
B. There are no upwards forces
C. The upward and downward forces are balanced, so he doesn't fall
D. The net force is downward and proportional to the square of his tangential velocity
E. Both B and D

Chapter 6 – Friction and Air Resistance

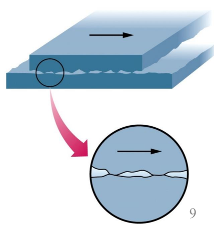
- Non-conservative forces (remove energy from the system)
- Oppose the motion
- Friction is proportional to the normal force
- Air resistance is proportional to the square of the velocity

Friction

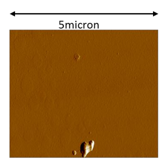
- Opposes the direction of motion
- Two kinds:
  - static friction $f_{s,max} = \mu_s F_N$
  - kinetic friction $f_k = \mu_k F_N$



- The origin of friction is the result of many interactions of rough parts of the surfaces of the two bodies
- Two highly-polished, extremely clean metal surfaces in vacuum will not slide past each other – they "cold-weld"
- Ordinary surfaces are very rough, and their microscopic contact area is much smaller than their apparent macroscopic contact area – but they can still cold-weld

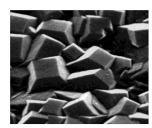


Surfaces – *an aside*



AFM PLD DLC on Si

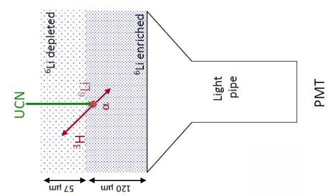
Very smooth



SEM CVD DLC on Si

Very rough

Surface used to guide neutrons



Used to detect neutrons

Two different types of glass cold-welded together – no glue or other bonding agent

Question

6.3.8. A 1.0 kg block is placed against a wall and is held stationary by a force of 8.0 N applied at a 45° angle as shown in the drawing. What is the magnitude of the friction force?

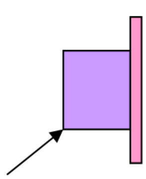
A. 3.7 N

B. 4.1 N

C. 5.8 N

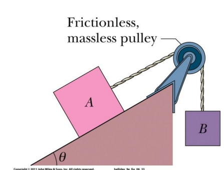
D. 7.0 N

E. 8.0 N



Example

HRW #6.27 - Body A in the figure weighs 102 N, and body B weighs 32 N. The coefficients of friction between A and the incline are $\mu_s = 0.56$ and $\mu_k = 0.25$. Angle is 40° . Let the positive direction of an x axis be up the incline. In unit-vector notation, what is the acceleration of A if A is initially



(a) at rest,
(b) moving up the incline, and
(c) moving down the incline.