March 4, 2013 Physics 131 Prof. E. F. Redish (for Prof. Upadhyaya)

- **Theme Music:** **Blue Man Group**

  Tension 2

- **Cartoon:** **Jef Mallet**

  Frazz

Notes

- Exam in class Thursday 11:00-11:50.
- Exam covers all readings through today.
- Course center hours this week as usual.
- Q&A session in 1412 Wednesday 5-6:50 (me)
- Tuesday morning lab – check ELMS for how missed lab is to be handled.

Foothold ideas: 3D Velocity

- Average velocity is defined by

$$\langle \vec{v} \rangle = \frac{\Delta \vec{r}}{\Delta t} = \frac{\text{vector displacement}}{\text{time it took to do it}}$$

Note: an average velocity goes with a <u>time interval</u>.

- Instantaneous velocity is what we get when we consider a very small time interval (compared to times we care about)

$$\vec{v} = \frac{d\vec{r}}{dt}$$

Note: an instantaneous velocity goes with a <u>specific time</u>.

Foothold ideas: Acceleration

- Average acceleration is defined by

$$\langle \vec{a} \rangle = \frac{\Delta \vec{v}}{\Delta t} = \frac{\text{change in velocity}}{\text{time it took to do it}}$$

Note: an average acceleration goes with a time interval.

- Instantaneous acceleration is what we get when we consider a very small time interval (compared to times we care about)

$$\vec{a} = \frac{d\vec{v}}{dt}$$

Note: an instantaneous acceleration goes with a specific time.

What have we learned? Representations and consistency

- Visualizing where an object is at different times → a position graph
- Visualizing how fast an object is moving at different times → a velocity graph
- Position graph → velocity graph

  $\boxed{\text{slopes } \langle v \rangle = \dfrac{\Delta x}{\Delta t}}$

- Velocity graph → position graph

  $\boxed{\text{areas } \ \Delta x = \langle v \rangle \Delta t}$

What have we learned?
Representations and consistency

- Visualizing how fast an object is at different times → a velocity graph
- Visualizing how an object changes v at different times → a velocity graph
- Velocity graph → accel. graph
- Accel. graph → velocity graph

slopes $\langle a \rangle = \dfrac{\Delta v}{\Delta t}$

areas $\Delta v = \langle a \rangle \Delta t$

Foothold Principles
Newton's Laws

- Newton 0:
  – An object responds to the forces it feels when it feels them.
- Newton 1:
  – An object that feels a net force of 0 keeps moving with the same velocity (which may = 0).
- Newton 2:
  – An object that is acted upon by other objects changes its velocity according to the rule

$$\vec{a}_A = \vec{F}_A^{net} / m_A$$

- Newton 3:
  – When two objects interact the forces they exert on each other are equal and opposite.

$$\vec{F}_{A\to B}^{type} = -\vec{F}_{B\to A}^{type}$$

Kinds of Forces

- Forces are what objects do to each other when they interact.
- Types of Force

$$\boxed{W = mg}$$

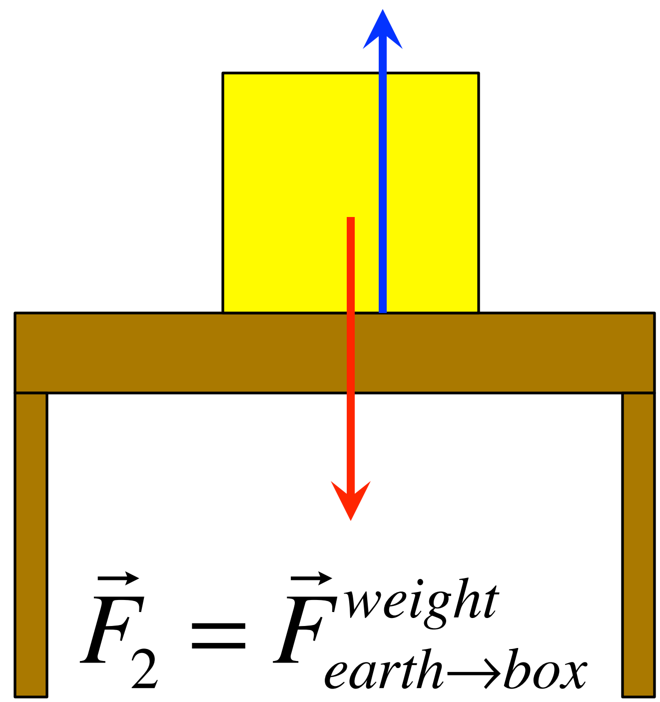
  - Normal: N
  - Tension: T $\quad \boxed{T = k\Delta L}$
  - Friction: f, F^D, F^V $\quad \boxed{f \le \mu N}$
  - Weight: W
  - Electric: F^E
  - Magnetic: F^M
- Notation convention.

$$\vec{F}^{\text{ type of force}}_{\text{(object causing force)}\rightarrow\text{(object feeling force)}}$$

Compare forces 1 and 2

1. Force 1 is bigger
2. Force 2 is bigger
3. They are equal in magnitude
4. There is not enough information to tell.

$$\vec{F}_1 = \vec{F}^{normal}_{table \to box}$$

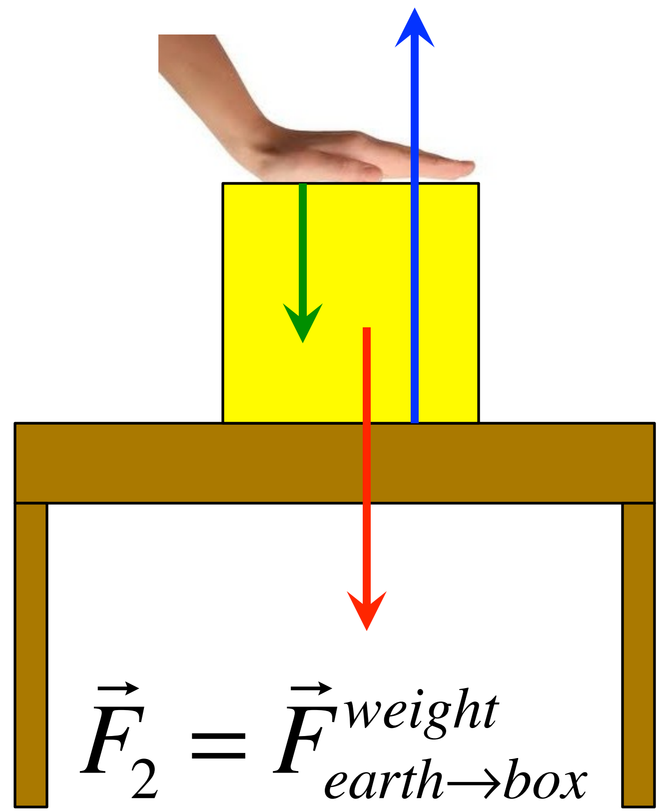


$$\vec{F}_2 = \vec{F}^{weight}_{earth \to box}$$

Compare forces 1 and 2

1. Force 1 is bigger
2. Force 2 is bigger
3. They are equal in magnitude
4. There is not enough information to tell.

$$\vec{F}_1 = \vec{F}^{normal}_{table \to box}$$

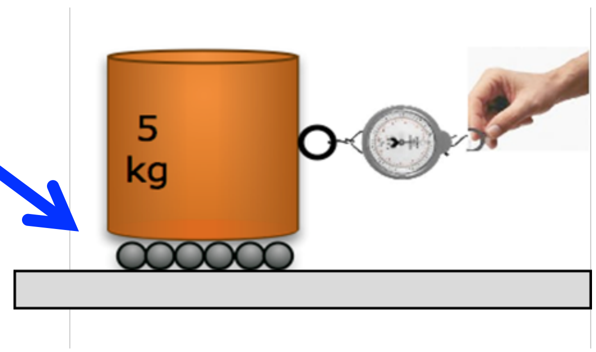


$$\vec{F}_3 = \vec{F}^{normal}_{hand \to box}$$

$$\vec{F}_2 = \vec{F}^{weight}_{earth \to box}$$

Very good wheels.
Ignore friction
With the table.

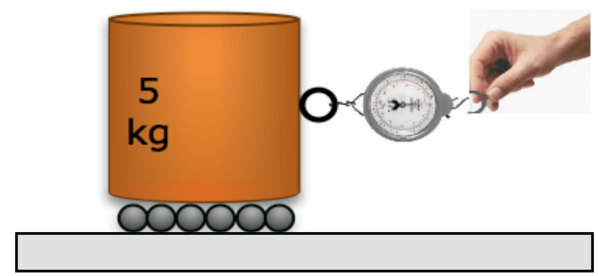
System Schema



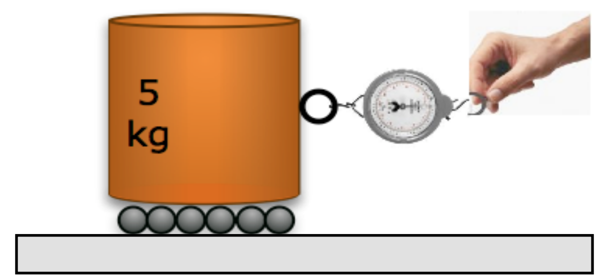
Free-Body Diagram

You are pulling the block along a table.
To ensure that the block speeds up at a constant rate you need to

1. Pull with a decreasing force.
2. Pull with a constant force.
3. Pull with an increasing force.
4. Not pull at all.



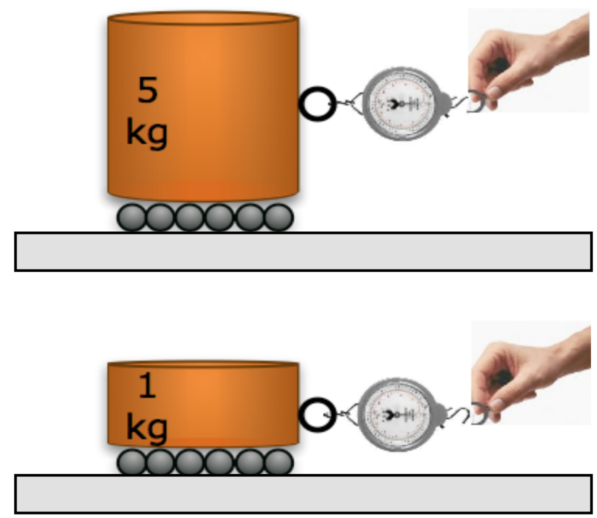
You are pulling the block along a table.
To keep the block moving at constant speed



1. Pull with a decreasing force.
2. Pull with a constant force.
3. Pull with an increasing force.
4. Not pull at all.

You are pulling two blocks along a table.
To insure that both speed up with the same acceleration which one requires a larger force?

1. The 1 kg weight block
2. The 5 kg weight block
3. The require the same force.
4. There is not enough information to tell.



You are pulling two blocks along a table with constant speed. Which one requires a larger force?

1. The 1 kg weight block
2. The 5 kg weight block
3. The require the same force.
4. There is not enough information to tell.