Physics 140 – Fall 2007
lecture 6 : 20 Sep

Ch 4/5 topics:

- Newton's laws of motion
- Newton's third law: action-reaction pairs

Notices:

- first midterm exam is **Thursday, 4 Oct, 6:00-7:30 pm**
- **need alternate time?** Explain your situation in an email
- practice exam posted to Ctools

  try unworked version first (answers on last page), then consult solutions

Fundamental Forces of Nature

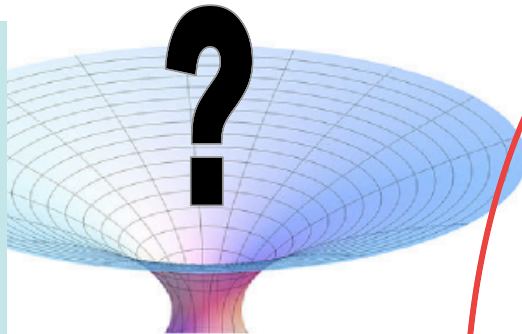
Sources: Undetermined

Gravity

Electromagnetism

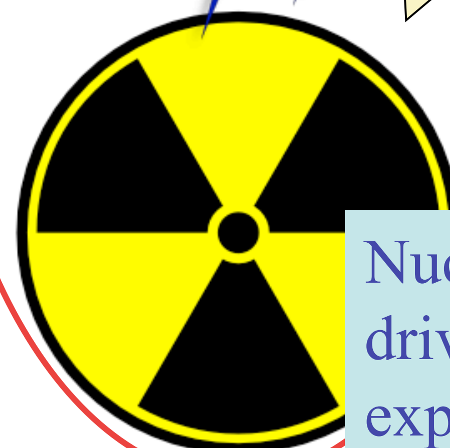
quantum gravity?

binds large objects together (but makes the universe fly apart on large scales!)



Life!
Contact forces!
Normal forces!
Friction!

binds atomic nuclei together, builds elements, powers stars



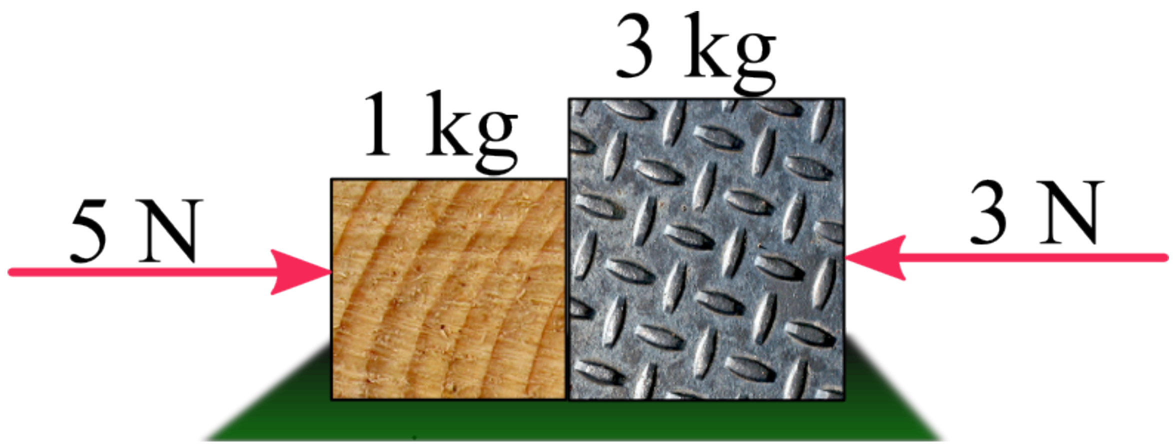
Nuclear fission, drives supernova explosions

Strong Force

Weak Force

quantum chromodynamics

quantum electrodynamics



On a horizontal, frictionless surface, the blocks above are being acted upon by two opposing horizontal forces, as shown. What is the magnitude of the **net force** acting on the 3kg block?

A. zero

B. 2N

C. 1.5 N

D. 1N

E. More information is needed.

Newton's Third Law: Action–Reaction Pairs

"To every action there is always imposed an equal reaction; or, the mutual actions of two bodies upon each other are always equal and directed to contrary parts."

Source: Undetermined

Given two bodies (A and B) that affect each other (by direct contact another means, like gravity), let $\boldsymbol{F}_{\text{A on B}}$ be the force on B caused by A and $\boldsymbol{F}_{\text{B on A}}$ the force on A caused by B. These forces are equal and opposite

$$\boldsymbol{F}_{\text{B on A}} = -\boldsymbol{F}_{\text{A on B}}$$

and are said to form a ***third-law pair***. Note that:

- the elements of third-law pairs *always act on different objects*. Their actions can therefore never cancel.
- third-law pairs can arise with any type of force (gravity, normal force, tension, etc.).
- if one element of a third-law pair is removed, the other must also vanish.

In a tug-of-war, team L pulls on team R with as large a force as it can. Likewise, team R pulls on team L. Eventually, team L prevails, as both teams shift to the left, and team L is declared the winner.

Which statement describing this situation is correct?

1. The winning team exerts a larger force on the losing team than the losing team exerts on the winning team.
2. The losing team exerts a larger force on the winning team than the winning team exerts on the losing team
3. The losing team exerts the same force on the winning team that the winning team exerts on the losing team.

Some tips for solving Newton's second law problems:

1. Think! Define the system (or set of systems).

- draw a cartoon and define your coordinate system(s).
- identify all the forces that are acting

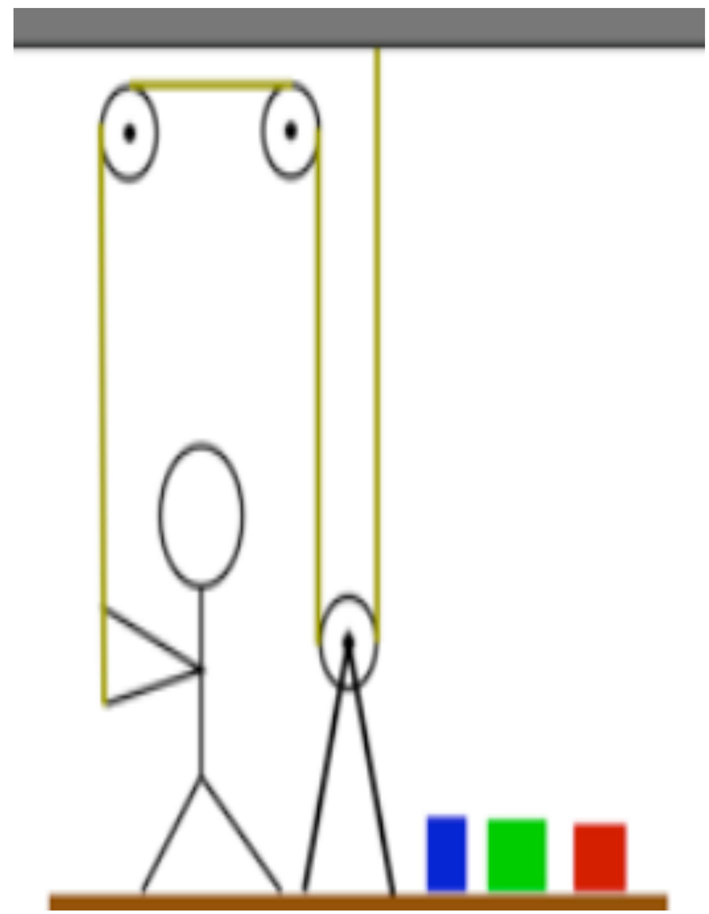
2. FBD. Draw a free-body diagram(s) for the system(s).

- imagine a bubble enclosing the system
- "shrink it to a dot"
- draw vector forces in the chosen coordinate system.
- apply Newton's 3rd law, if needed, at interfaces.

3. NSL. Apply $\Sigma \boldsymbol{F} = m\,\boldsymbol{a}$

- in *static* situations, $\Sigma \boldsymbol{F} = 0$.
- in *dynamic* situations involving multiple objects, find the links between the objects (e.g., same acceleration)

A hi-rise window installer is pulling a platform and its contents (himself and some equipment) up the side of a building using pulleys and a rope, as shown. If he is pulling so that the tension in the rope is $\boldsymbol{T}$, what total force does he exert on the platform and its contents?



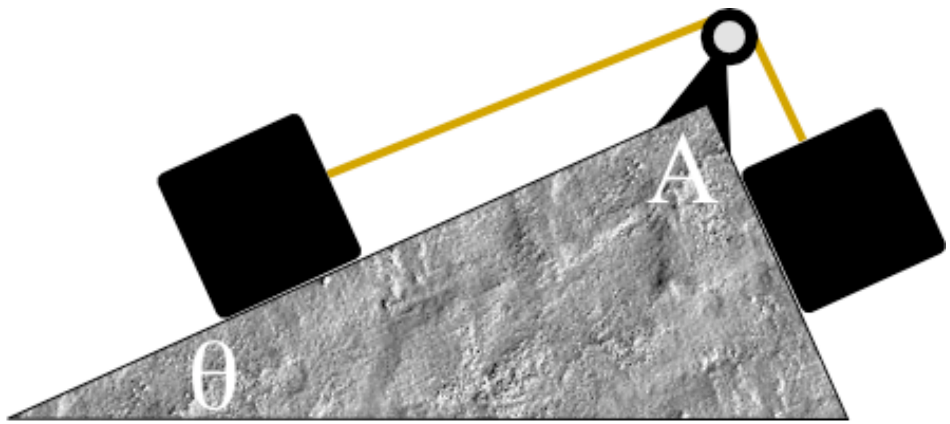
A. $\boldsymbol{T}$

B. $2\boldsymbol{T}$

C. $3\boldsymbol{T}$

D. $4\boldsymbol{T}$

E. $5\boldsymbol{T}$



Two identical masses are attached to either end of a very light rope draped across the very light pulley as shown. If angle A is a right angle, then the magnitude of the acceleration of the blocks expressed in terms of the tilt angle θ is

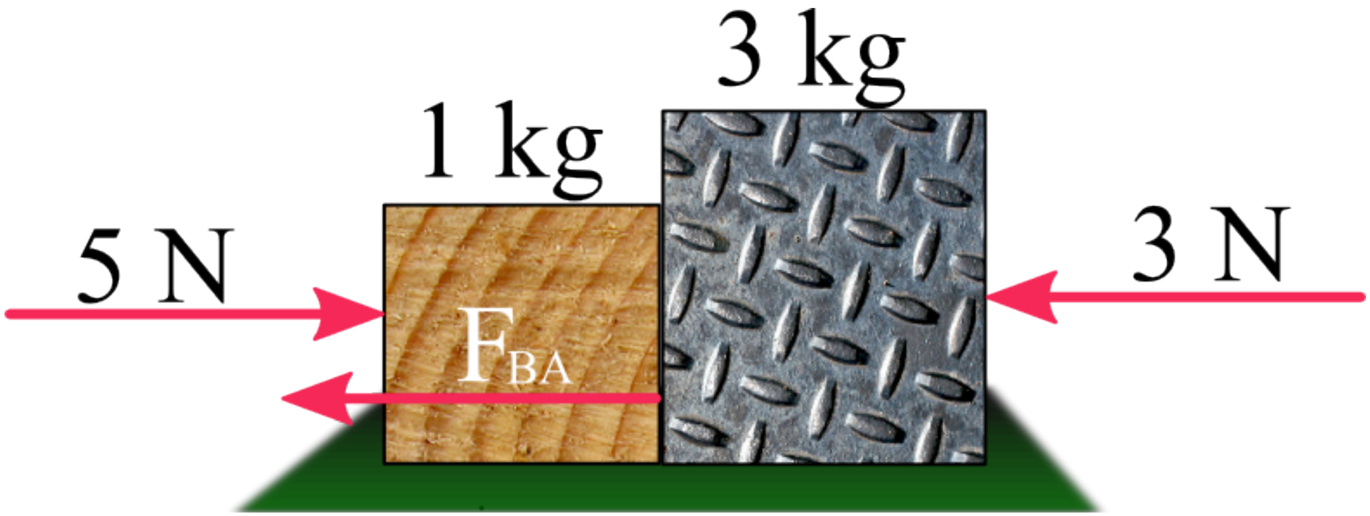
A. $2g \cos\theta$

B. $g/2 \sin\theta$

C. $2g (\cos\theta - \sin\theta)$

D. $g/2 (\sin\theta + \cos\theta)$

→ E. $g/2 (\cos\theta - \sin\theta)$



Taking the + $\boldsymbol{i}$ direction to the right, what is the contact force that block B exerts on block A?

A. zero

B. –1.5 $\boldsymbol{i}$

C. –4.5 $\boldsymbol{i}$

D. 1.5 $\boldsymbol{i}$

E. 4.5 $\boldsymbol{i}$

F. –6.0 $\boldsymbol{i}$