Physics 211

Sections 1 & 70
Dr. Geoffrey Lovelace
Fall 2012
Lecture 9 (9/27/12)

Lecture 9 outline

- Announcements
- Laws of motion
  - Newton's 3 laws of motion
  - Weight & mass
  - Example: blocks & strings
- Exam results

Announcements

- Exams graded; grades posted to Titanium soon
- Homework #4: due today, 11:59PM
  - Projectiles
  - Forces, laws of motion
- Homework #5: assigned today, due in 1 week
  - Forces, Laws of motion
  - Will announce on piazza when available
- Reading: chapter 4

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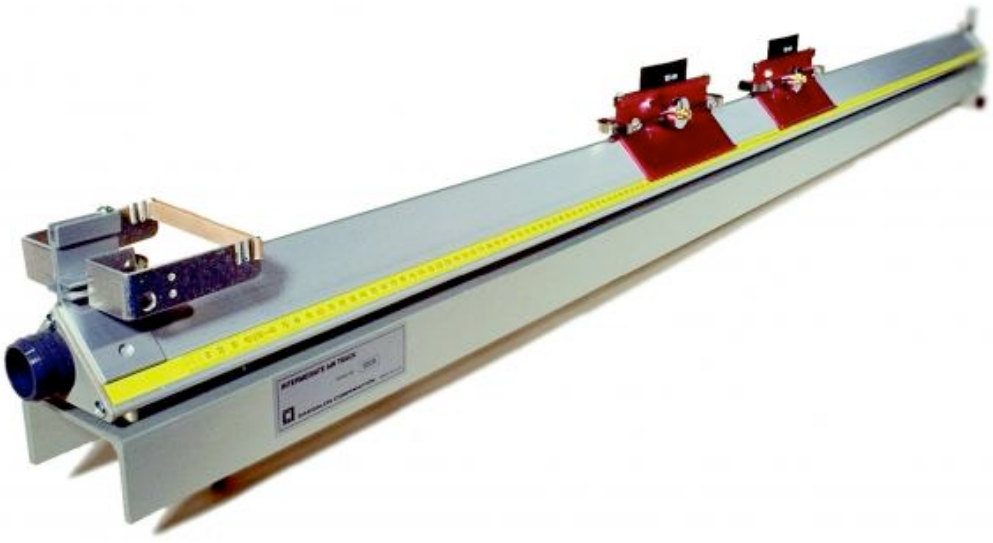
Newton's first law

- Net force: $\vec{\mathbf{F}}_{\mathrm{net}} \equiv \Sigma \vec{\mathbf{F}}_{\mathrm{i}}$
- If the **net force** on an object is zero…
  - If at rest, object remains at rest
  - If moving, moves at a constant velocity
- Demo: air track, air soccer



Clicker question #34

Question 4.2a Cart on Track I

Consider a cart on a horizontal frictionless table. Once the cart has been given a push and released, what will happen to the cart?

A. slowly come to a stop

B. continue with constant acceleration

C. continue with decreasing acceleration

D. continue with constant velocity

E. immediately come to a stop

Clicker question #32

Question 4.1b Newton's First Law II

A hockey puck slides on ice at constant velocity. What is the *net* force acting on the puck?

A. more than its weight

B. equal to its weight

C. less than its weight but more than zero

D. depends on the speed of the puck

E. zero

Clicker question #37

Question 4.1a Newton's First Law I

A book is lying at rest on a table. The book will remain there at rest because:

A there is a net force but the book has too much inertia

B there are no forces acting on it at all

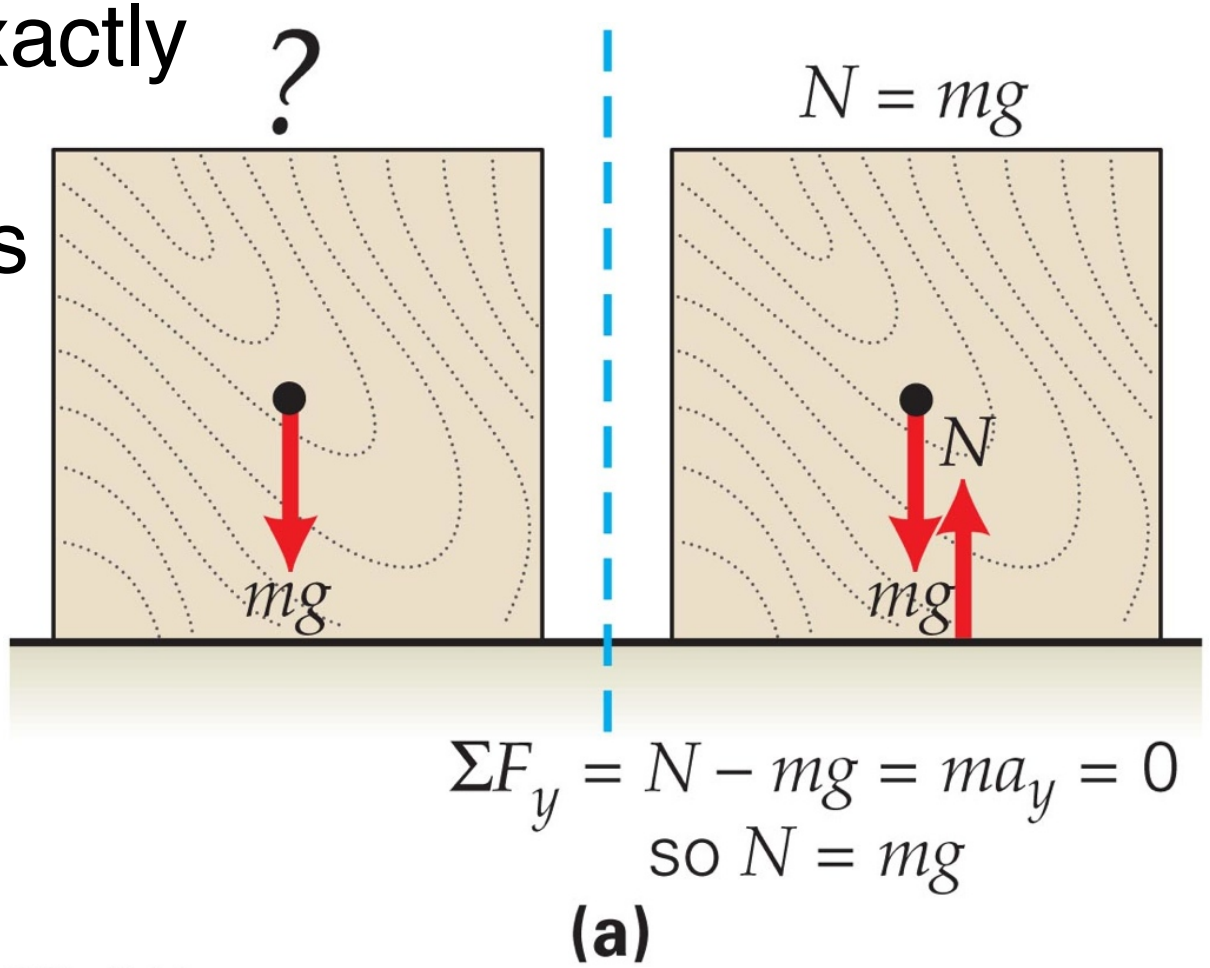
C it does move, but too slowly to be seen

D there is no net force on the book

E there is a net force, but the book is too heavy to move

Normal force

- Normal force
  - Direction: perpendicular to surface
  - Magnitude: exactly enough so object remains on surface



Normal force

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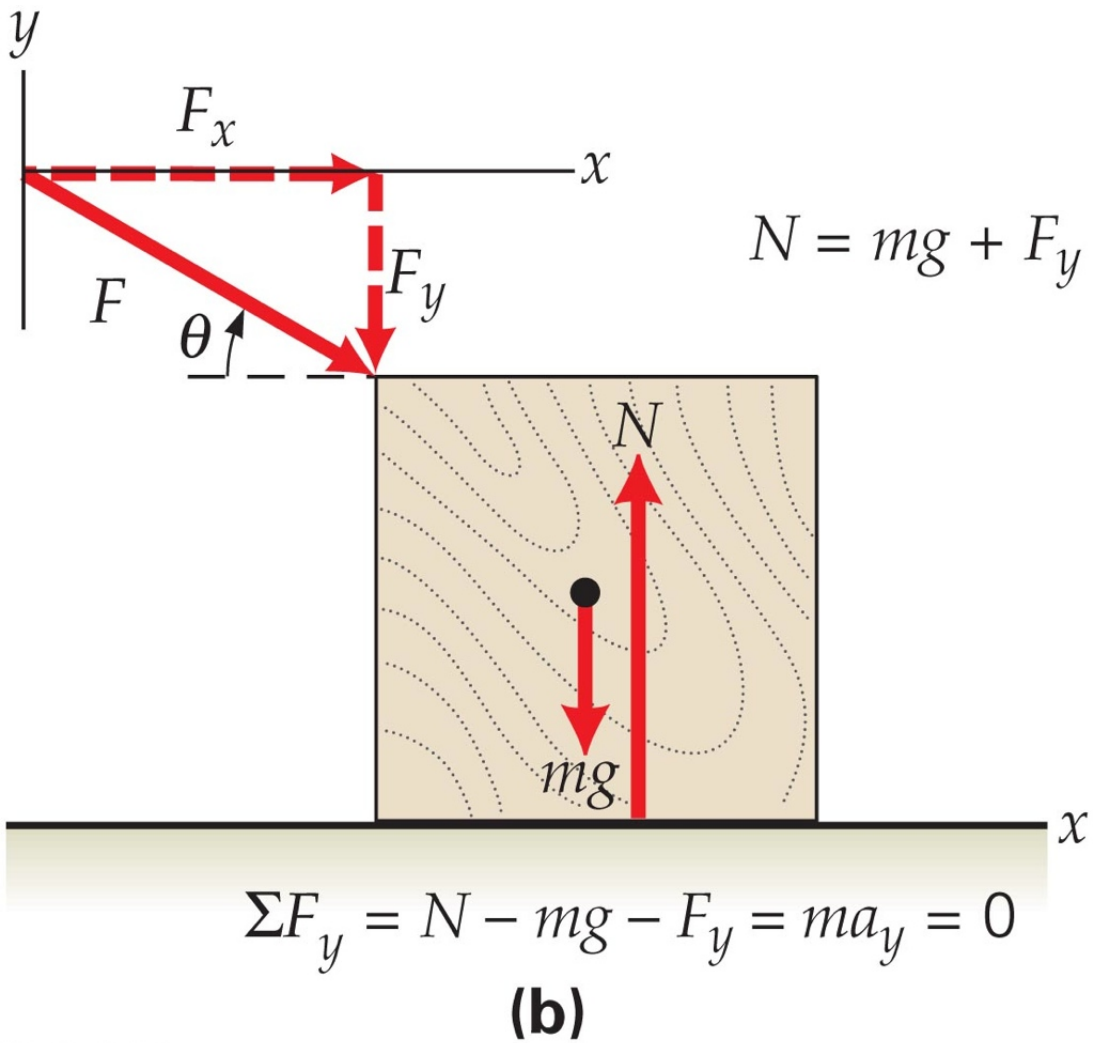
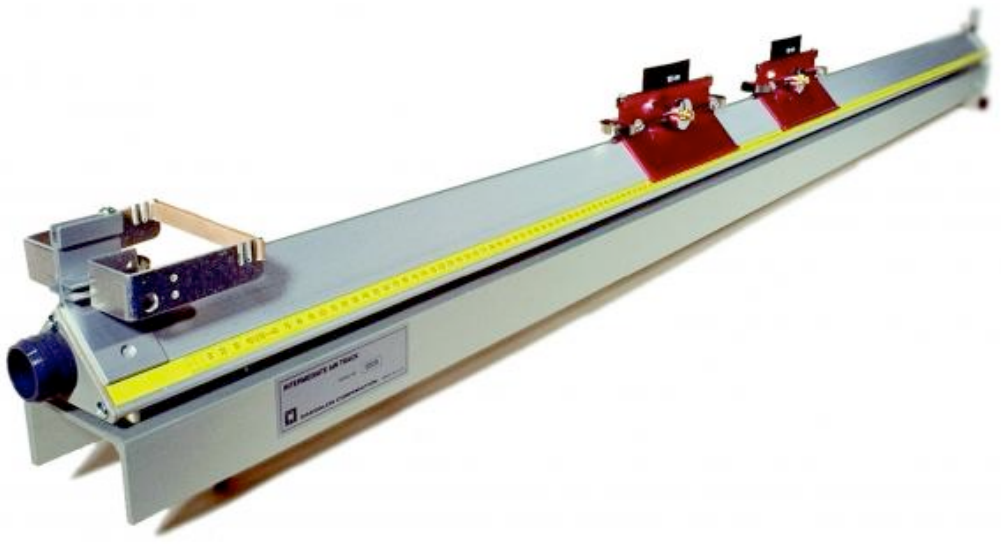


Newton's second law

- If the **net force** on an object of mass *m* is nonzero…

$$\vec{\mathbf{a}} = \frac{\vec{\mathbf{F}}_{\text{net}}}{m}$$

  - Vector equation
  - Applies to entire system or to parts of system
- Demo: air track



Clicker question #35

Question 4.2b Cart on Track II

A cart pushed & released on a frictionless track moves at constant velocity. What would have to be done in order to have the cart continue with constant acceleration?

A push the cart harder before release

B push the cart longer before release

C push the cart continuously

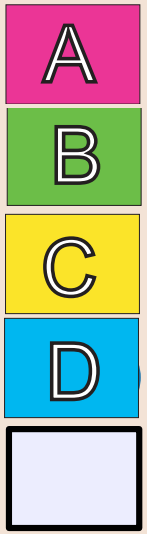
D change the mass of the cart

it is impossible to do that

Clicker question #37

Question 4.5 Force and Mass

A force *F* acts on mass *M* for a time interval *T*, giving it a final speed *v*. If the *same* force acts for the *same* time on a different mass *2M*, what would be the final speed of the bigger mass?



4v

2v

v

½v

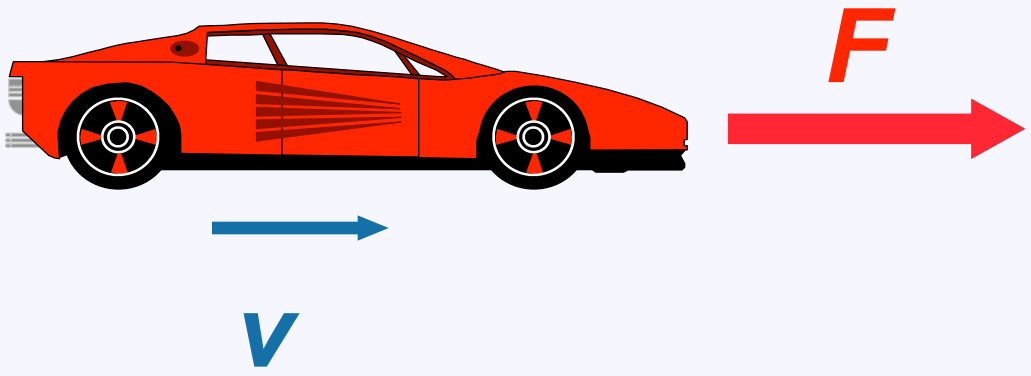
¼v

Clicker question #31

Question 4.4a Off to the Races I

From rest, we step on the gas of our Ferrari, providing a force *F* for 4 secs, speeding it up to a final speed *v*. If the applied force were only ½ *F*, how long would it have to be applied to reach the *same* final speed?

A	16 s
B	8 s
C	4 s
D	2 s
	1 s



Newton's third law

- If force $\vec{\mathbf{F}}_{\mathrm{AB}}$ *on* A *by* B, then…
  - Force *on* B *by* A is $\vec{\mathbf{F}}_{\mathrm{BA}} = -\vec{\mathbf{F}}_{\mathrm{AB}}$
  - Relates forces acting on *different* objects
- Demo: the wall pushes me around
- Video: fire extinguisher & skateboard

  http://www.youtube.com/watch?v=kioIcgnQqpY
  http://www.youtube.com/watch?v=pVRgfDSAGOA

Clicker question #38

- WALL-E is moving rightward and wants to slow down. Which way should he aim?

A →

B ←

C Not enough info

D Not sure

Clicker question #38a

- WALL-E is moving rightward and wants to slow down. Which arrow is his desired acceleration?

A →

B ←

C Not enough info

D Not sure

Clicker question #38b

- WALL-E wants to accelerate left. Which direction should be force **on** Wall-E by pellets?

A →

B ←

C Not enough info

D Not sure

Clicker question #38c

- WALL-E wants to accelerate left. Which way should he point the fire extinguisher?

A →

B ←

C Not enough info

D Not sure

Clicker question #38c

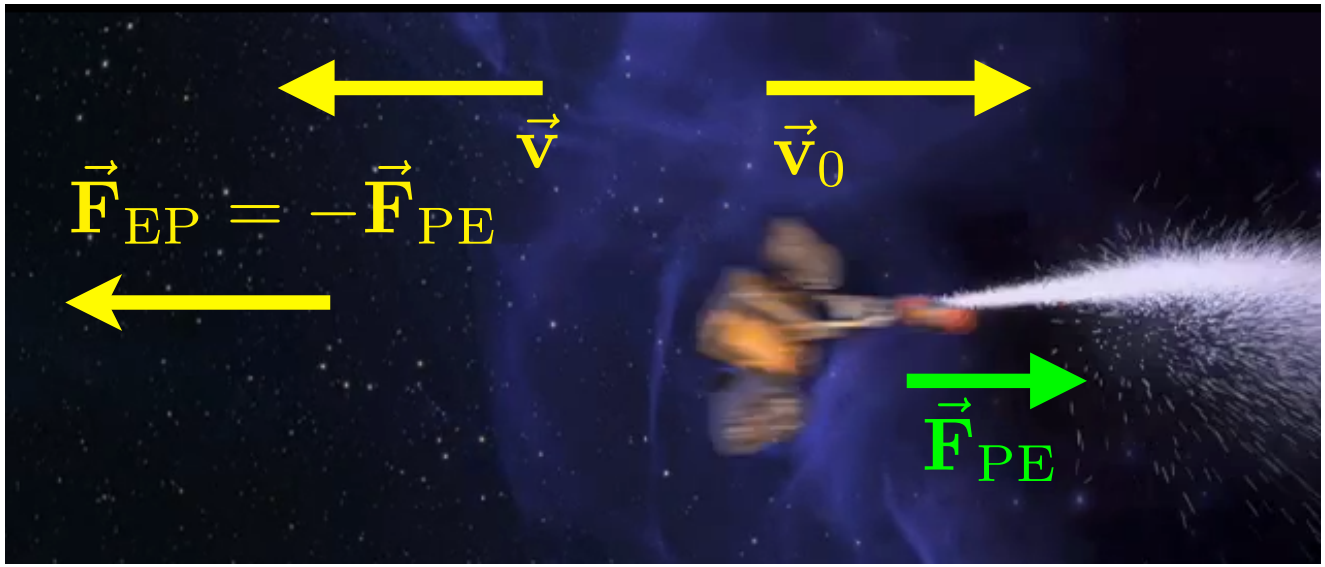
- WALL-E wants to accelerate left. Which way should he point the fire extinguisher?

A →

B ←

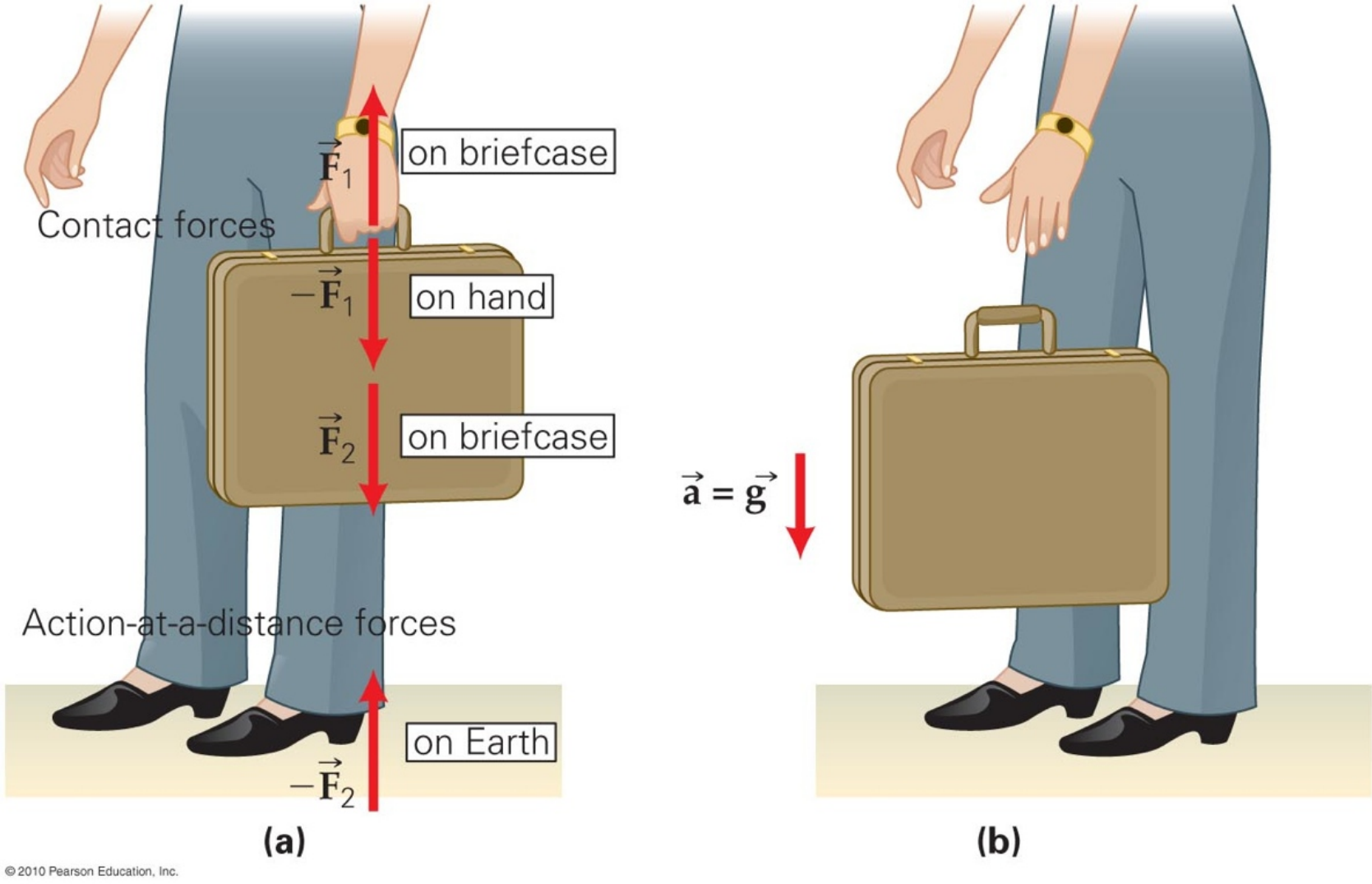
C Not enough info

D Not sure



Newton's third law

- Con. Ex. 4.5 in textbook: find all force pairs



Newton's 3 laws

- Summary
  - 1. $\text{If } \vec{\mathbf{F}}_{\text{net}} = \vec{\mathbf{0}} \text{ then } \vec{\mathbf{a}} = \vec{\mathbf{0}}$
  - 2. $\text{If } \vec{\mathbf{F}}_{\text{net}} \neq \vec{\mathbf{0}} \text{ then } \vec{\mathbf{a}} = \dfrac{\vec{\mathbf{F}}_{\text{net}}}{m}$
  - 3. $\vec{\mathbf{F}}_{\text{BA}} = -\vec{\mathbf{F}}_{\text{AB}}$
- The challenges
  - Conceptual: often counter-intuitive predictions
  - Quantitative: applying to problems

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  - Example: blocks & string: next time
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Exam results

- 39 points possible, +2 points added to all, average = 78.5%
- Questions? Review your exam? Stop by my office hours