Physics 211

Sections 1 & 70

Dr. Geoffrey Lovelace

Fall 2012

Lecture 8 (9/19/12)

Lecture 8 outline

- Announcements
- Survey results
- Relative velocity
  - Video: example of frames of reference
  - Computing velocities in different frames of reference
- Laws of motion
  - Force & net force
  - Introduction to first & second laws of motion
  - Example: projectile motion

Announcements

- Today at 11:59PM: Homework #3 due
- Tuesday, September 25 (Tuesday!): Exam #1
  - Bring: #2 pencils, eraser, sci. calculator
  - I provide: scantron form, formula sheet
- Homework #4 due in 1 week
  - Projectile practice & relative velocity
  - Introduction to the laws of motion

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Survey results

- Most unsure about projectiles
  - Homework #4 includes a projectile tutorial
  - Last office hours before exam today
- Format for examples
  - 59% — PowerPoint better
    - Easier to read, more organized
  - 14% — Whiteboard better
    - Shows more steps, better for math
  - 15% — Use both

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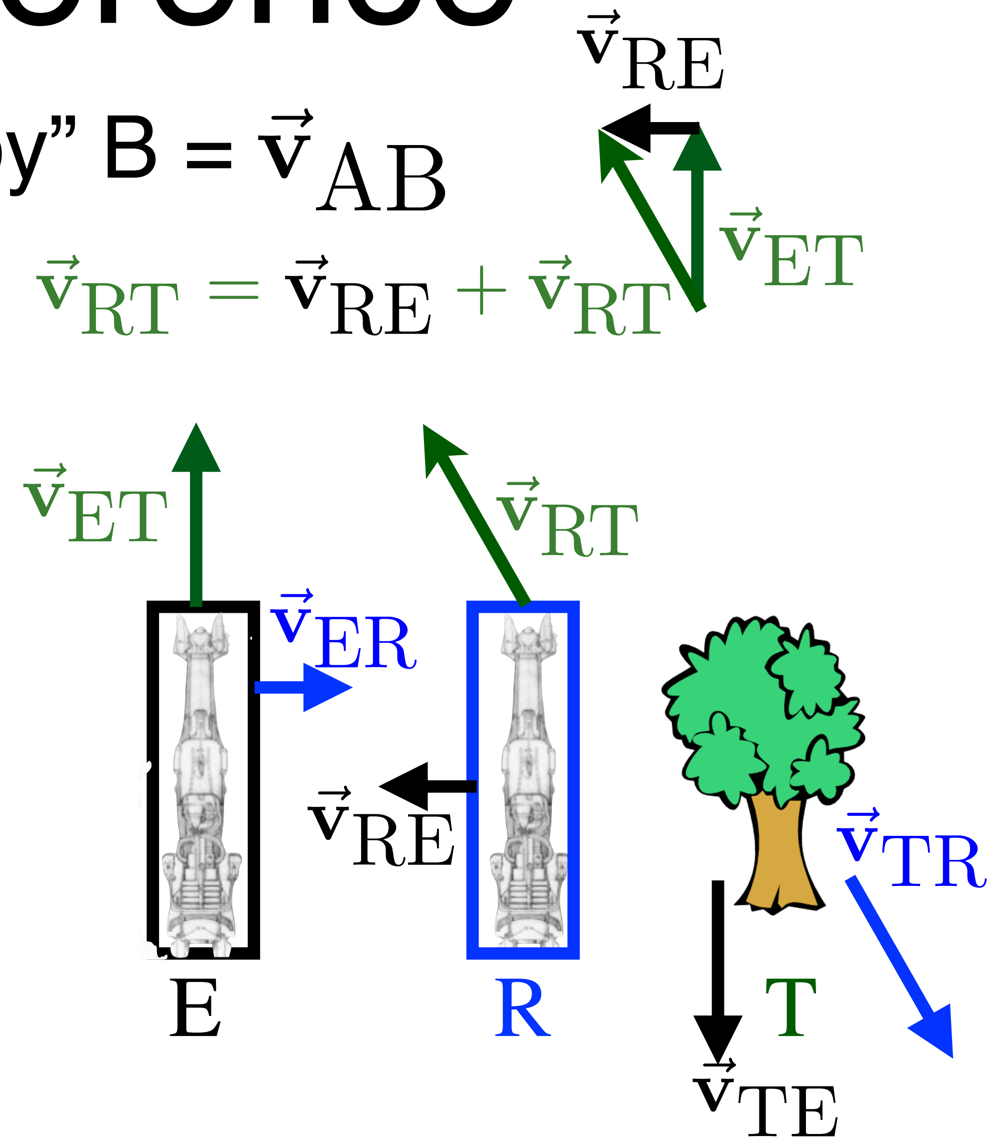
Frames of reference

- Velocity of A "as seen by" B = $\vec{\mathbf{v}}_{\mathrm{AB}}$
- $\vec{\mathbf{v}}_{\mathrm{AB}} = -\vec{\mathbf{v}}_{\mathrm{BA}}$
- $\vec{\mathbf{v}}_{\mathrm{AB}} = \vec{\mathbf{v}}_{\mathrm{AC}} + \vec{\mathbf{v}}_{\mathrm{CB}}$



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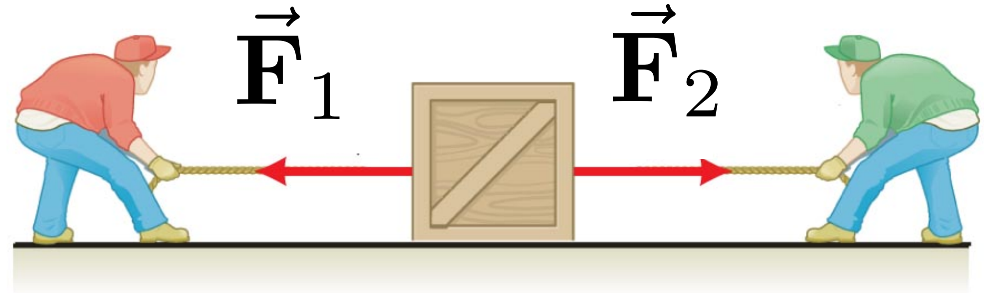
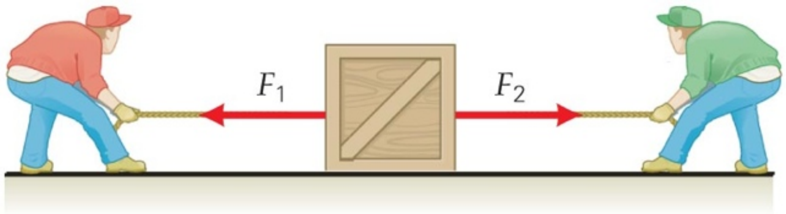
Force

- Ch. 2-3: *kinematics* = description of motion
- Ch. 4: dynamics = causes of motion
- Force
  - Something capable of *accelerating* an object
    - Contact: push/pull
    - Action-at-a-distance: e.g. gravity
  - Force is a vector



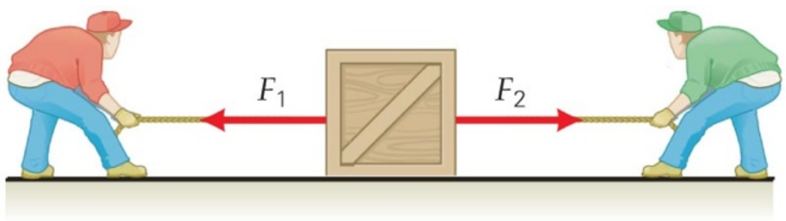
(a)

Net force & acceleration



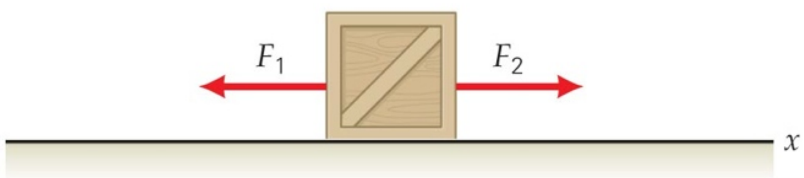
$$\vec{\mathbf{F}}_{\text{net}} = \Sigma \vec{\mathbf{F}}_i = \vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2 + \cdots$$

Net force & acceleration

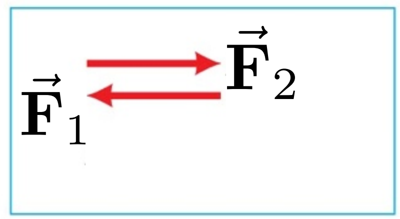


(a)

$$\vec{\mathbf{F}}_{\text{net}} = \Sigma \vec{\mathbf{F}}_i = \vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2 + \cdots$$

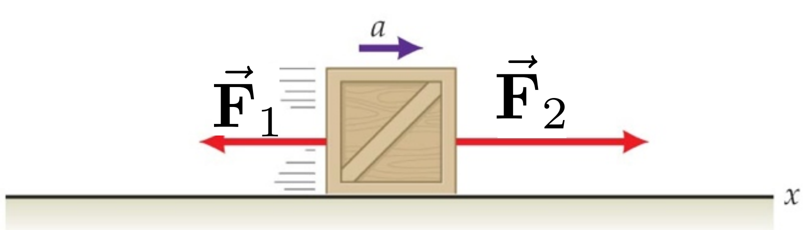


(b) Zero net force (balanced forces)

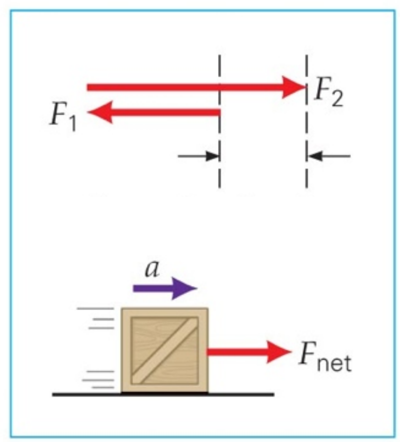


$$\vec{\mathbf{F}}_{\text{net}} = \vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2 = 0$$

$$\vec{\mathbf{a}} = 0$$



(c) Nonzero net force (unbalanced forces)



$$\vec{\mathbf{F}}_{\text{net}} = \vec{\mathbf{F}}_1 + \vec{\mathbf{F}}_2 \neq 0$$

$$\vec{\mathbf{a}} \neq 0$$

Mass

- Inertia = tendency of an object to remain at rest or to remain in uniform motion (const. velocity)
  - How much an object "resists" accelerating
- Mass = measure of inertia (units kg)
  - Example: computers with same performance

2004
Power Mac G5
18 kg

2012
iPhone 5
0.1 kg

First 2 laws of motion

- First law: If $\vec{\mathbf{F}}_{\mathrm{net}} = \mathbf{0}$, then…
  - Object at rest remain at rest
  - Object in motion remains in motion at a constant velocity
- Second law: If $\vec{\mathbf{F}}_{\mathrm{net}} \neq \mathbf{0}$, then…
  - Object of mass *m* accelerates: $\vec{\mathbf{a}} = \dfrac{\vec{\mathbf{F}}_{\mathrm{net}}}{m}$

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?

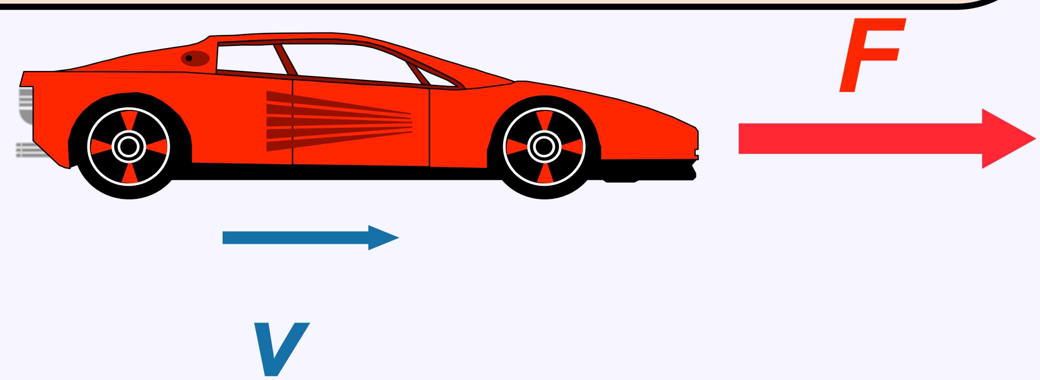
A 16 s

B 8 s

C 4 s

D 2 s

1 s



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

zero

Clicker question #33

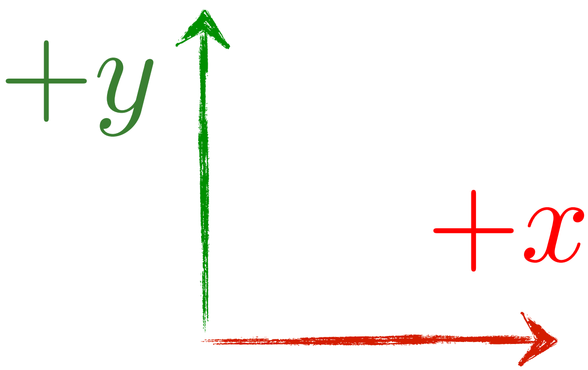
Question 4.1c Newton's First Law III

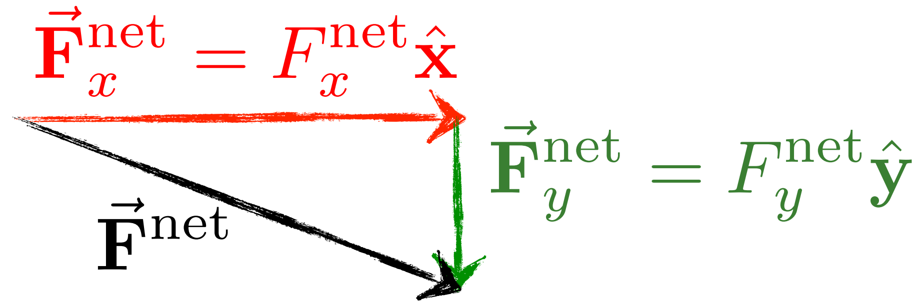
You put your book on the bus seat next to you. When the bus stops suddenly, the book slides forward off the seat. Why?

A. a net force acted on it
B. no net force acted on it
C. it remained at rest
D. it did not move, but only seemed to
E. gravity briefly stopped acting on it

Force is a vector

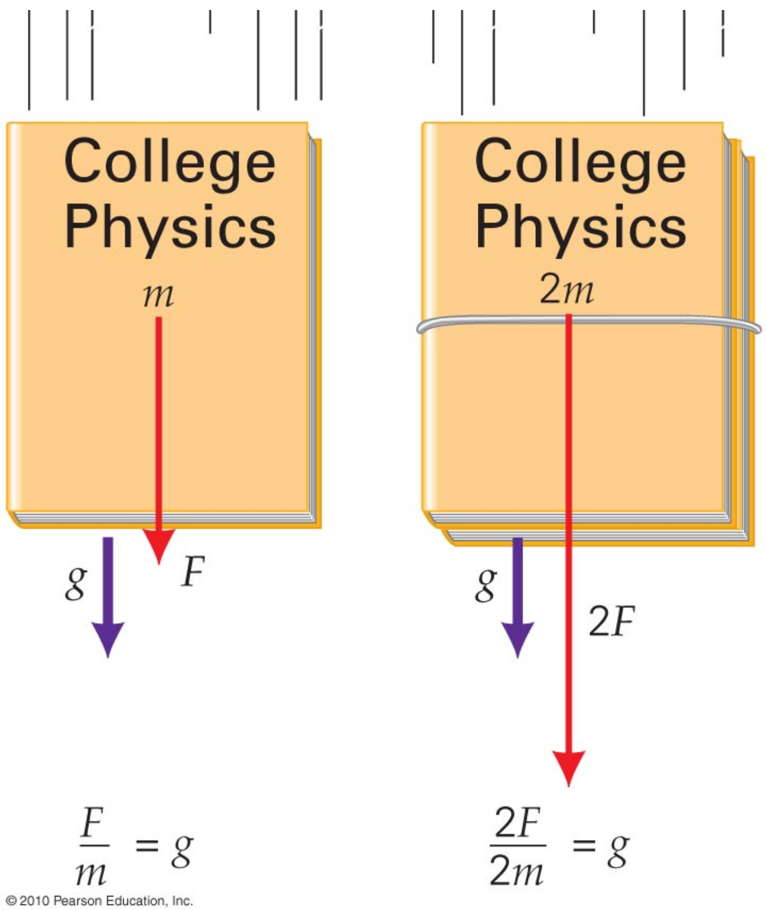
$$\vec{\mathbf{a}} = \frac{\vec{\mathbf{F}}_{\text{net}}}{m} \quad \Longrightarrow \quad a_x = \frac{F_x^{\text{net}}}{m}, \qquad a_y = \frac{F_y^{\text{net}}}{m}$$

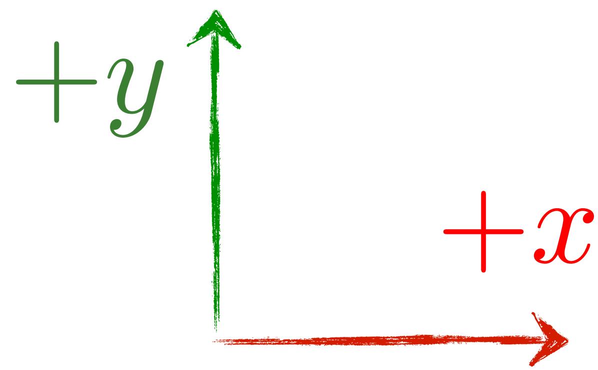




Weight

- Weight = force of gravity





$$\vec{\mathbf{F}}_{\text{grav}} = \vec{W} = m\vec{\mathbf{g}} = -mg\hat{\mathbf{y}}$$

$$a_y = \frac{F_y}{m} = \frac{-mg}{m} = -g$$

Projectiles

- Only force is weight

Vertical motion: 2nd law

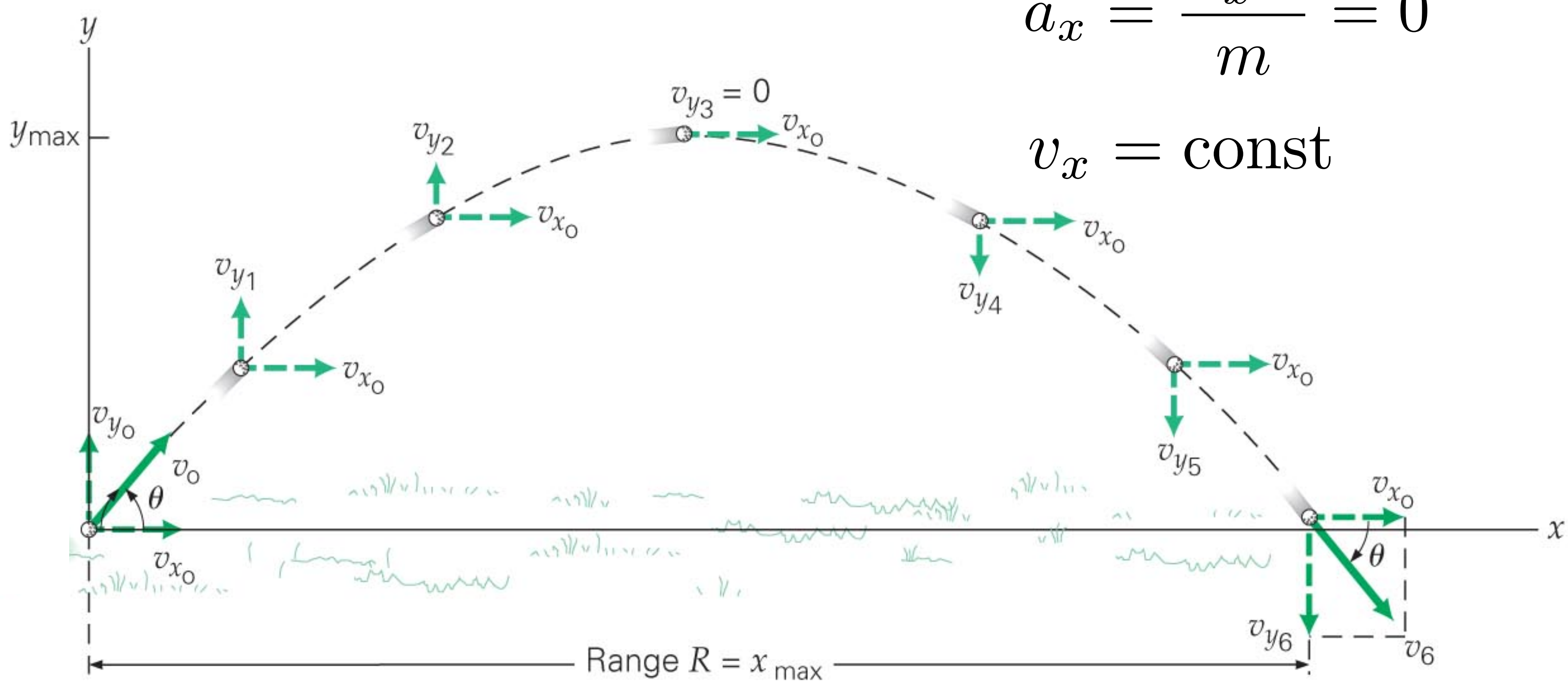
$$\vec{\mathbf{F}}_{\text{grav}} = \vec{W} = m\vec{\mathbf{g}} = -mg\hat{\mathbf{y}}$$

$$a_y = \frac{F_y^{\text{net}}}{m} = \frac{-mg}{m} = -g$$

Horizontal motion: 1st law

$$a_x = \frac{F_x^{\text{net}}}{m} = 0$$

$$v_x = \text{const}$$



Clicker question #28c

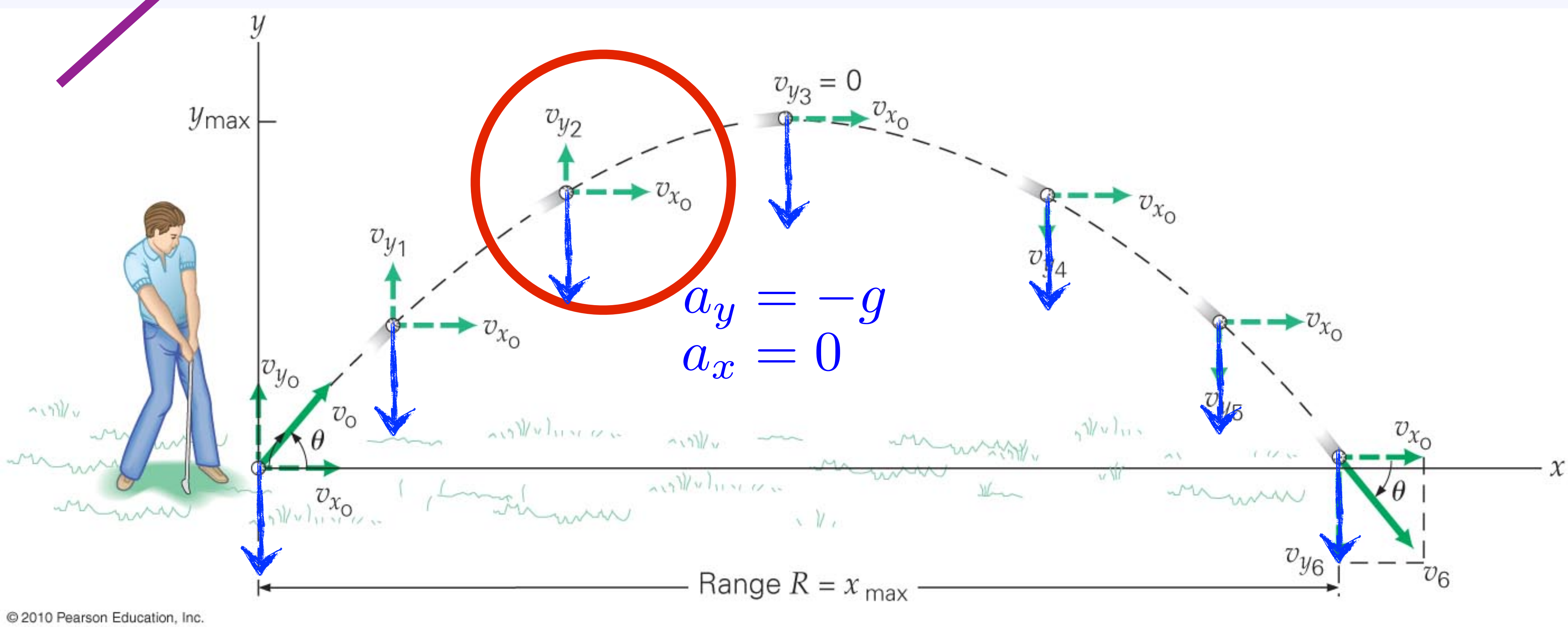
Which is the *acceleration* at the circled time?

A

B

C

D



Class participation #8

1. Name
2. Equation (describe or write) that you most wish will be on the formula sheet for the exam