

# **Interactive Learning Toolkit: Tools for the Interactive Classroom**

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**Mazur Group  
Division of Engineering & Applied Sciences  
Harvard University**

**University of Limerick  
17 Dec 2003**

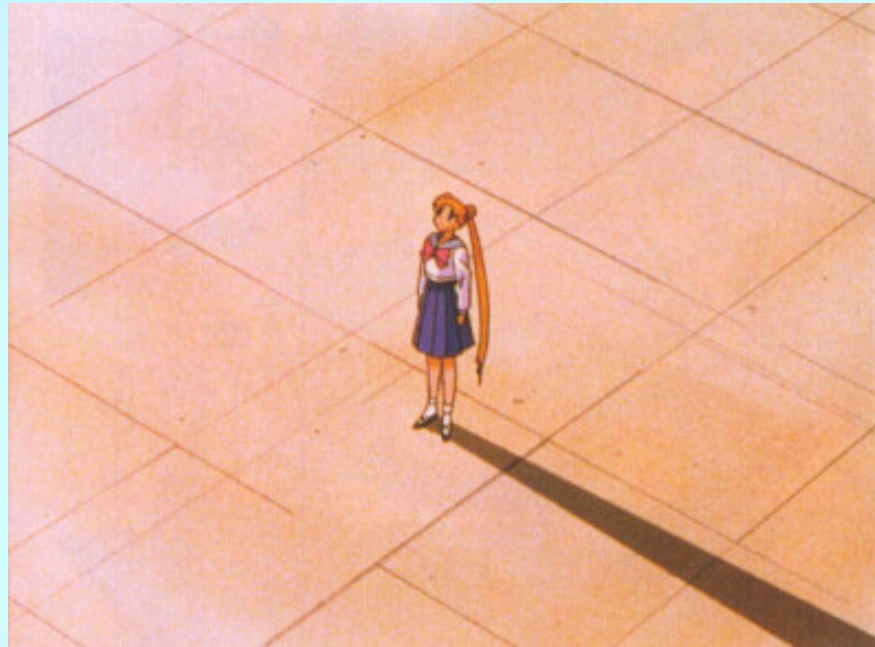


# ***Outline***

- ▶ **Interactive Teaching Techniques**
- ▶ **Web-based support**
- ▶ **Summary**
- ▶ **Resources**

## ***The 'large lecture' problem***

**Students passively receive information  
with no emphasis on interaction**



# ***PhD Research***

**68% of students do not have the ability,  
motivation or discipline for self-study!**

**Ref:** McCauley (2002) *PhD Thesis*. University of Limerick.

# ***PhD Research***

**Shift the focus in lecture from delivering to synthesizing information**

**Ref:** McCauley (2002) *PhD Thesis*. University of Limerick.

## ***The solution***

- ▶ **Information transfer - outside classroom:**

**Just in Time Teaching**

- ▶ **Discussion, interaction - in classroom:**

**Peer Instruction**

## ***Just in Time Teaching Strategy***

- ▶ **Pre-lecture reading assignment  
(2 X content and 1 X feedback)**
- ▶ **Graded on effort - 10% final grade**

**Ref:** Novak et al. (1999) See: [www.jitt.org](http://www.jitt.org)





## ***Just in Time Teaching works!***

- ▶ **Improves preparation**
- ▶ **Feedback**
- ▶ **Better use of class time**

**Ref:** Novak et al. (1999) See: [www.jitt.org](http://www.jitt.org)

# ***Peer Instruction***

**Promotes student interaction**

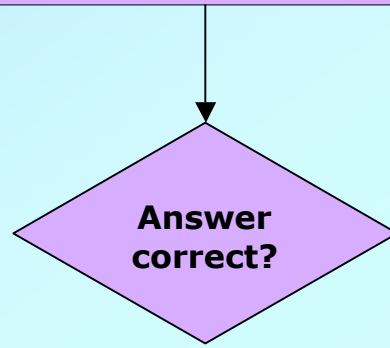
**Ref:** Mazur (1997) Prentice Hall.

# ***Peer Instruction***

- 1. Pose question**
- 2. Think**
- 3. First answer**

# ***Peer Instruction***

- 1. Pose question**
- 2. Think**
- 3. First answer**



# ***Peer Instruction***

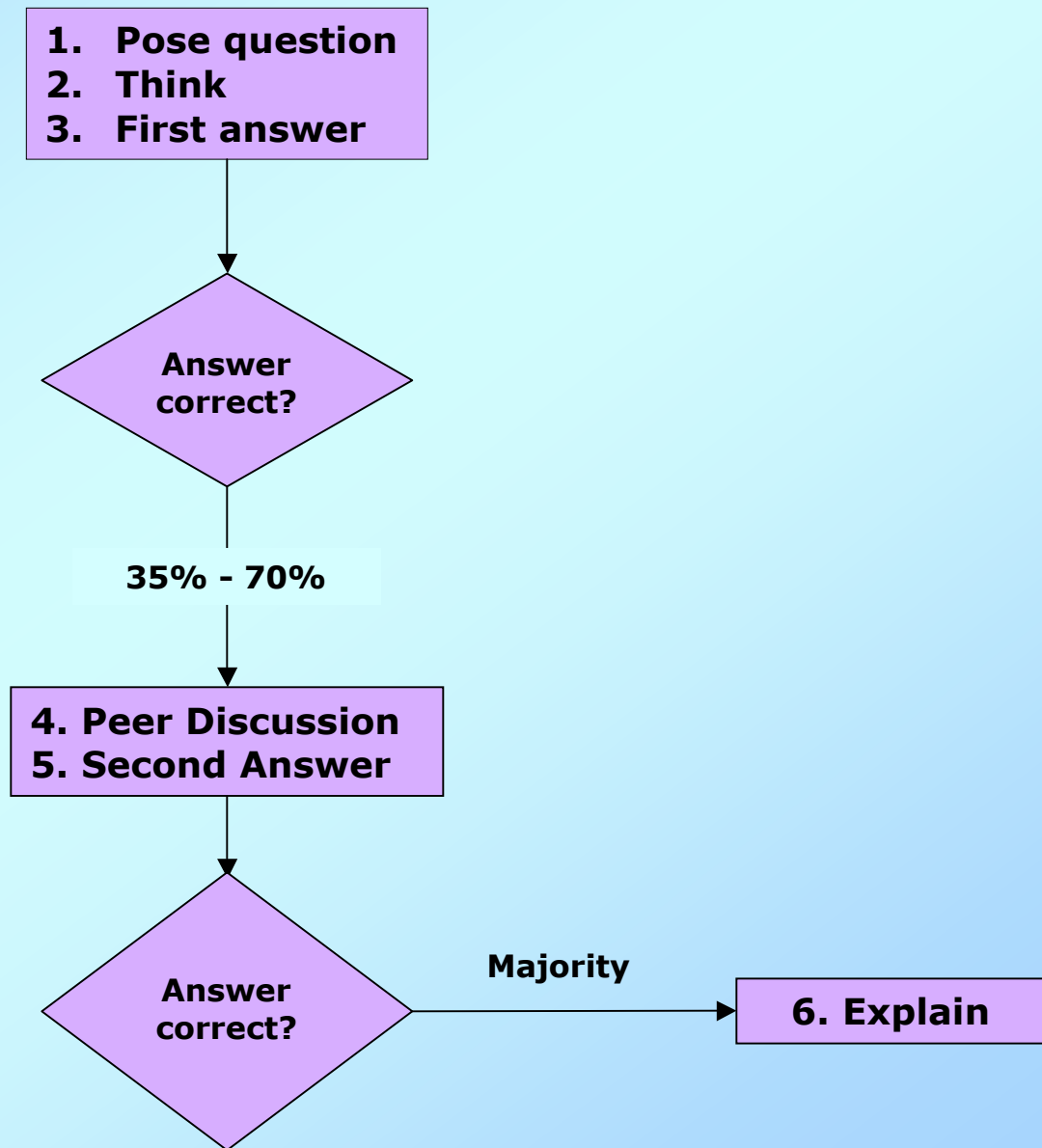
- 1. Pose question**
- 2. Think**
- 3. First answer**

**Answer  
correct?**

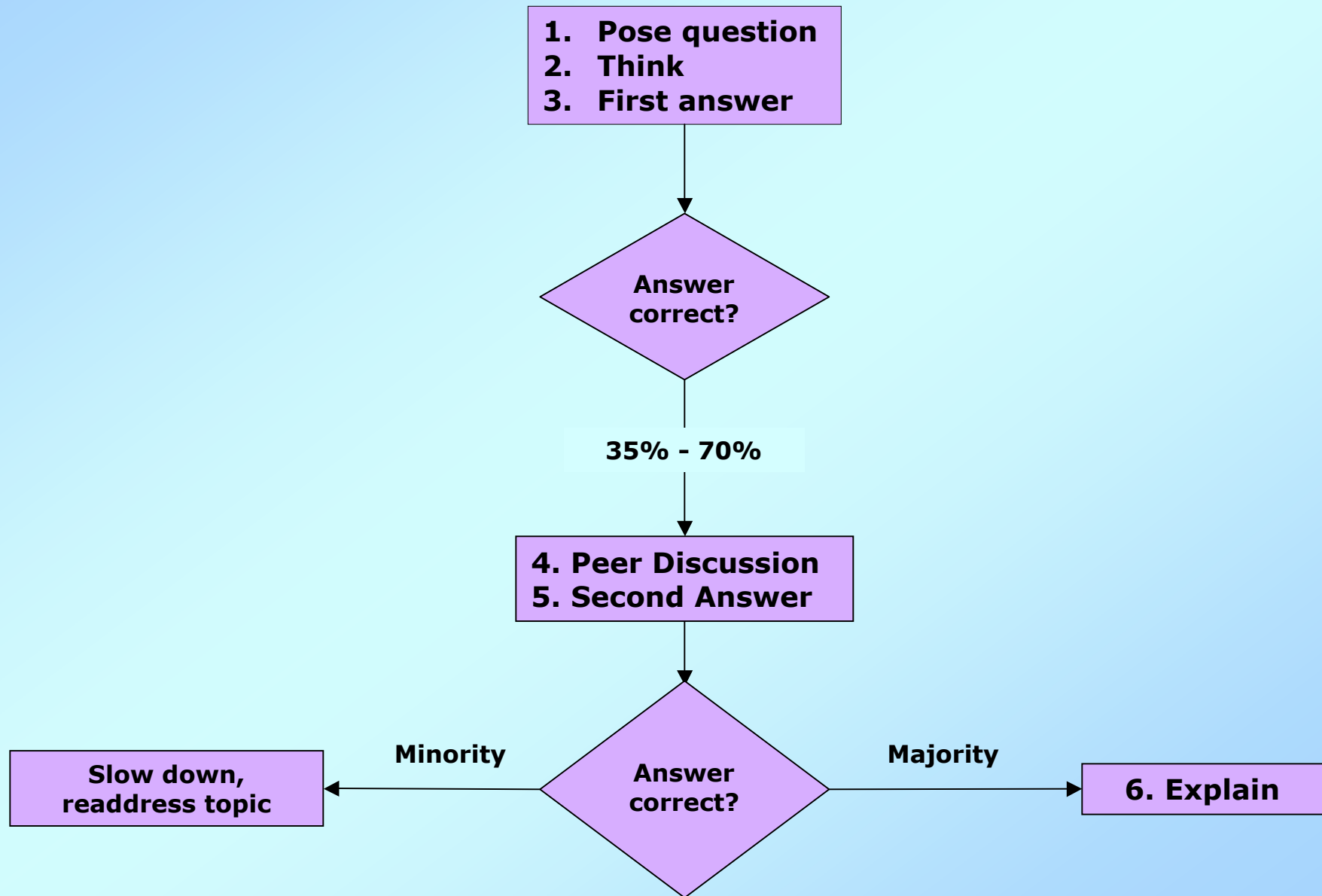
**35% - 70%**

- 4. Peer Discussion**
- 5. Second Answer**

# *Peer Instruction*



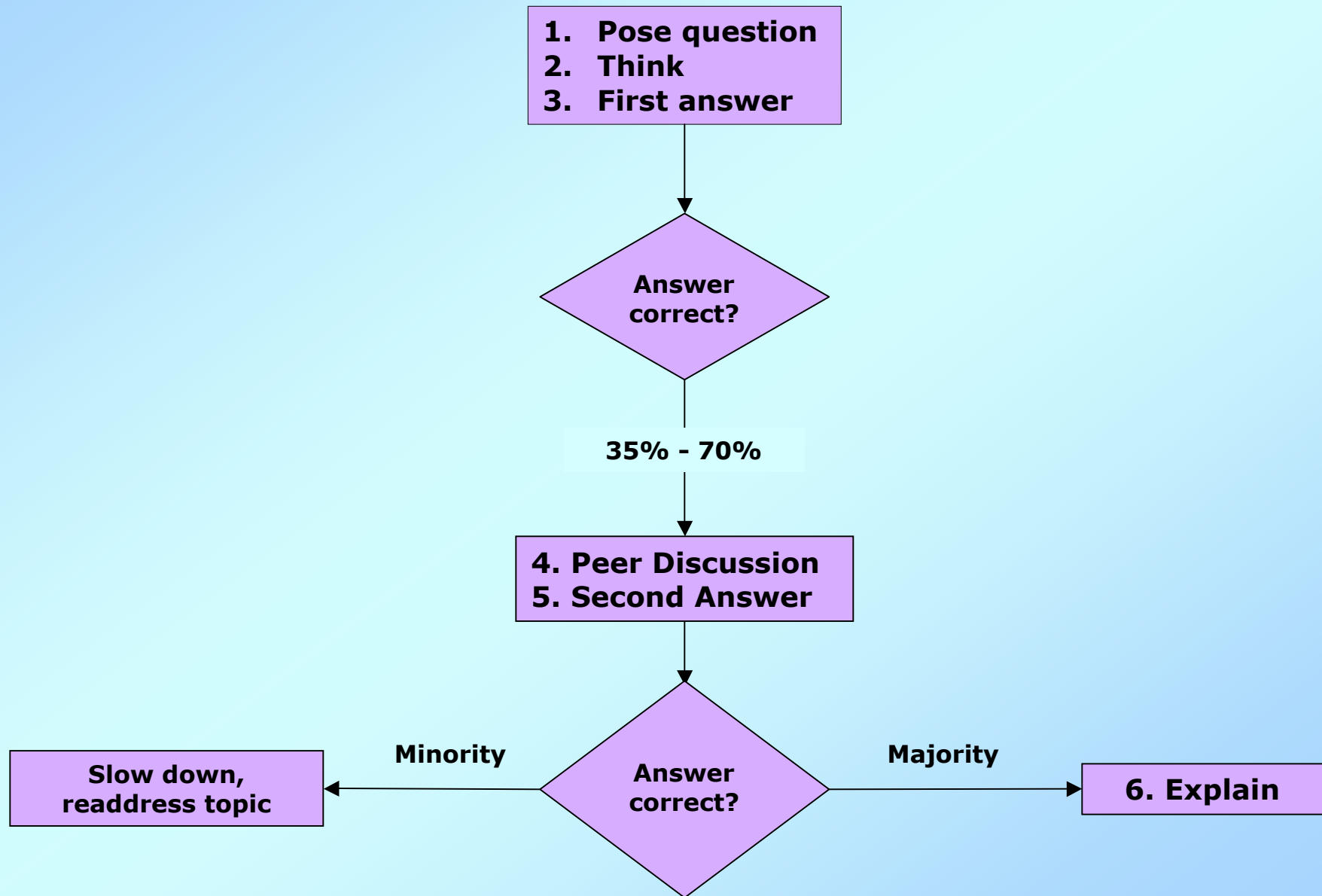
# *Peer Instruction*



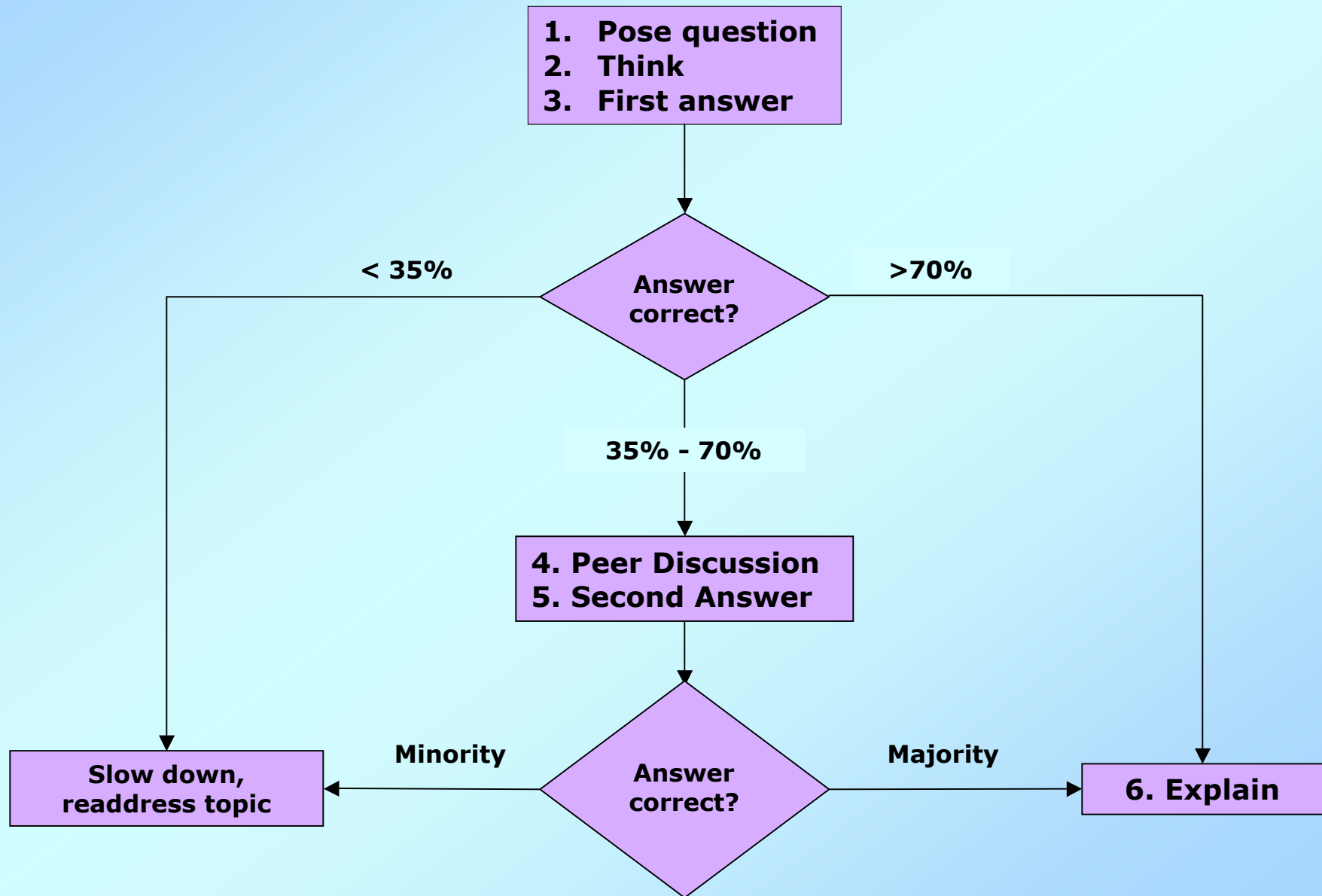




# *Peer Instruction*



# *Peer Instruction*





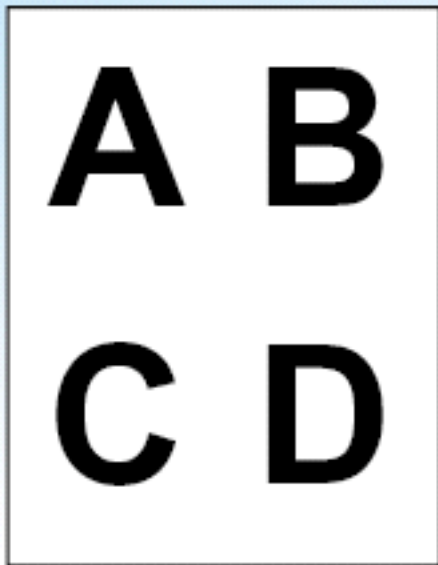
# ***Feedback***

- **PRS - Personal Response System**



# ***Feedback***

- **PRS - Personal Response System**
- **Flashcards**



## ***Feedback***

- **PRS - Personal Response System**
- **Flashcards**
- **Colour Cards**

## ***Feedback***

- **PRS - Personal Response System**
- **Flashcards**
- **Colour Cards**
- **Heads down/Hands up**

# Interactive Learning Toolkit [ILT]

[www.deas.harvard.edu/galileo](http://www.deas.harvard.edu/galileo)



# Create calendar-based lecture schedule

[Courses](#) > [Physics 1b](#) > [Lectures](#) > [Create Schedule](#)

Set the start and end dates for your lecture. Select the days of week of your lecture. Add a header that will show up in the student view of the lecture. You can also set when the students can access the lecture content. Select the time, whether it is to be available before or after the start of the lecture. You can also change the enrollment dates for the students.



**Start date:** Sep 10 2003

**End date:** Jan 31 2004

**Lectures on:** ☐ Mon ☐ Tues ☒ Wed ☐ Thurs ☒ Fri ☐ Sat ☐ Sun

**Lecture start:** 9 : 00 am Eastern Standard Time

**Lecture duration:** 1 Hrs : 30 Mins

**Student Access:** 1 hours after start of lecture

**Lecture header:**

**Enrollment dates:** Sep 1 2003 - Sep 7 2003

Create

# Create Reading Assignment schedule

## READING

## LECTURES

## ASSIGNMENTS

## FORUMS

## NEWS

## HANDOUTS

[Courses](#) > [Physics 1b](#) > Create Reading Automatically

Use this page to create a schedule of reading assignments. Each lecture will have a reading assignment associated with it. Use this page to specify how long before the lecture you want to publish the assignment to students. Also specify when you want to make it due.




**At what time do you want the reading assignment to be made available?**

At 12 : 00 AM

day(s) before start of lecture

**At what time do you want the reading assignment to be due?**

At 6 : 00 PM 

**1** day(s) before start of lecture

Create

# Add questions to Reading Assignment

**READING** **LECTURES** **ASSIGNMENTS** **FORUMS** **NEWS** **HANDOUTS**

[Courses](#) > [Physics 1b](#) > [Reading](#) > [Lecture 1](#) > Add Question

**Question Text:**

☐ **Multiple choice question:**

1

2

3

4

5

Correct?

Correct?

Correct?

Correct?

Correct?

**Answer:**

# Students respond to Reading Assignment

Courses > Physics 1b > Reading > Electrostatics > >

☐ edit

1. Suppose that objects A and B are electrically charged and are observed to attract each other. Both A and B are observed to attract a third object C. Is it true or false that these observations, if correct, would imply the existence of three different kinds of charge? Explain your reasoning.

☐ edit

2. Consider three charged particles carrying nonzero charges  $q_1$ ,  $q_2$ , and  $q_3$ . The vector sum of the forces exerted by 1 and by 2 on 3 is zero. Is it true that (a) 3 must necessarily lie somewhere along the line connecting 1 and 2 or (b) 3 must lie somewhere along that line, but only between 1 and 2?

☐ edit

3. Please tell us briefly what **single** point of the reading you found most difficult or confusing. If you did not find any part of it difficult or confusing, please tell us what parts you found most interesting.

Readings > Current Reading

**Due:** 6/29/2003 at 11:59 PM  
**Status:** Not completed

1. Suppose that objects A and B are electrically charged and are observed to attract each other. Both A and B are observed to attract a third object C. Is it true or false that these observations, if correct, would imply the existence of three different kinds of charge? Explain your reasoning.

**Answer:**








2. Consider three charged particles carrying nonzero charges  $q_1$ ,  $q_2$ , and  $q_3$ . The vector sum of the forces exerted by 1 and by 2 on 3 is zero. Is it true that (a) 3 must necessarily lie somewhere along the line connecting 1 and 2 or (b) 3 must lie somewhere along that line, but only between 1 and 2?

**Answer:**

3. Please tell us briefly what **single** point of the reading you found most difficult or confusing. If you did not find any part of it difficult or confusing, please tell us what parts you found most interesting.

**Answer:**

# Responses: work, face & name connected

Student	Answer	Time	Response
	<a href="#">Mysha Mason</a> terminology question – are neutral objects considered to be electrically charged (i.e. their charge is zero), or just positive and negative objects?	2/3/2003 7:59:16 pm	0 / 2
	<a href="#">Alyssa Berman</a> Pg. 12 of the reading states that "any two dissimilar materials become charged when brought in contact." Why, then, is no "static electricity" created when wood is rubbed against wool, for example? (Unlike glass against silk.)	2/3/2003 8:47:20 pm	0 / 2
	<a href="#">Leslie Garbarino</a> I had difficulty reading the force diagrams for different charges. It was tricky to figure out which forces were acting on which particles, given attraction and repulsion and also the fact that in a set of two particles, each is exerting a separate force on the other. I would like to see a diagram like this drawn out and have each force named as it is drawn. It would help me get a hold on them as opposed to seeing a bunch of arrows on the paper.	2/3/2003 9:23:39 pm	0 / 2
	<a href="#">Christine Tran</a> I found the concept of elementary charge confusing, and I am still hoping that I can get more clarification about Coulomb's Law – that part is still shaky for me.	2/3/2003 9:29:44 pm	0 / 2
	<a href="#">Andrea Li</a> 26.7 was conceptually difficult for me, the electrostatic equilibrium example specifically.	2/3/2003 10:20:37 pm	1 / 2
	<a href="#">Neil Shah</a> I had a bit of difficulty understanding why a neutral object is attracted to a charged object and not repelled by the charged object (since the neutral object has equal amounts of both charges).	2/3/2003 10:27:58 pm	1 / 2
	<a href="#">Lisa Simpson</a> The last 2 sections on coulumb's law was a bit confusing. Some of the notation and the math was not as clear as i would have hoped. Perhaps more numerical examples to help show the application of the equation into real charges.	2/3/2003 10:50:46 pm	1 / 2

# Response email to a RA question


http://qemp.de

Apple Visualizat

READING

ALL ANSWERS | Create CT

Please tell us briefly what single point of the reading you found most difficult or confusing. If you did not find any part of it difficult or confusing, please tell us what parts you found most interesting.



From: Emilia Asare <easare@fas.harvard.edu> (responded)

Received: Fri, 21 Feb 2003 18:09:34 -0500

I am confused about part b of Checkpoint 29.6 I don't really understand why there is no electrostatic force between C and B. After further reading, I figured that this is probably an equipotential line, but I don't really understand how we would know that from the diagram.

RESPONSE

Please tell us briefly what single point of the reading you found most difficult or confusing. If you did not find any part of it difficult or confusing, please tell us what parts you found most interesting.

See notes

To: Emilia Asare <easare@fas.harvard.edu>

Subject:

Dear Emilia,

Hope this helps,

Eric Mazur

Send without saving to FAQ

Edit or copy over FAQ response:

← (CT in class to address point) Reading assignment

← (Lack of specifics) Reading assignment

← (Referring to question) Reading assignment

← (Section 29.1) work-energy diagrams

← (Section 29.2) work in nonuniform field

← (Section 29.2) potential and sign of charge

FAQ

Reduce original response to simple question:

I am confused about part b of Checkpoint 29.6 I don't really understand why there is no electrostatic force between C and B. After further reading, I figured that this is probably an equipotential line, but I don't really understand how we would know that from the diagram.

Index question: (e.g., Section 10.2, Checkpoint 6.7)


☐ Hide from students

☐ Global


Send & save to FAQ

Student


Ans




Ale  
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on  
kin  
pot




Ant  
anc




Em  
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# Select ConcepTest Q's from database

[READING](#) [LECTURES](#) [ASSIGNMENTS](#) [FORUMS](#) [NEWS](#) [HANDOUTS](#)

Courses > VU Course > Introduction > Add CT

Please select the CTs you want to add to your lecture and click "Add to lecture". You can also click "Generate slides" to produce slides of question selected. You can modify your search or perform a new search using the search tools on the left. You can change the view of the CTs using the "Expand all" or "Collapse all" links on the left. X

1 - 10 of 156 CTs > >| Sort by: Question text Sort

☐

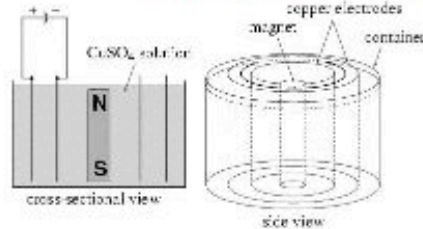
Physics > Introductory Electromagnetism > DC Circuits > CT: 3874  
October 17, 2001 02:03:23 pm

1. Consider two identical resistors wired in series. If there is an electric current through the combination, the power dissipated in each resistor is:  
1. equal to  
2. half  
3. smaller than, but not necessarily half

☐

Physics > Introductory Electromagnetism > Magnetism > CT: 3983  
October 1, 2001 00:00:00 am


2. A  $\text{CuSO}_4$  solution is placed in a container housing coaxial cylindrical copper electrodes....  
1. positive.  
2. negative.  
3. both positive and negative.  
...



☐

Physics > Introductory Electromagnetism > Magnetism > CT: 3980  
October 1, 2001 00:00:00 am

3. A battery establishes a steady current around the circuit below. A compass needle is placed successively at points P, Q, and R. The direction of the magnetic field at each point is:  
1. P, Q, R.  
2. Q, R, P.  
3. R, Q, P.  
...



# Create your own ConcepTest Q's

[READING](#) [LECTURES](#) [ASSIGNMENTS](#) [FORUMS](#) [NEWS](#) [HANDOUTS](#)

[Courses](#) > [VU Course](#) > [Introduction 2/4](#) > **Create ConcepTest**

Add a new ConcepTest x

Introductory text of your question.

Upload image ...

Text to appear after image.

1

Multiple choice no. 1

2

Multiple choice no. 2

1

More choices

Add choices in bulk

Text to appear after answer choices.

Explanation of answer.

Upload explanatory image...

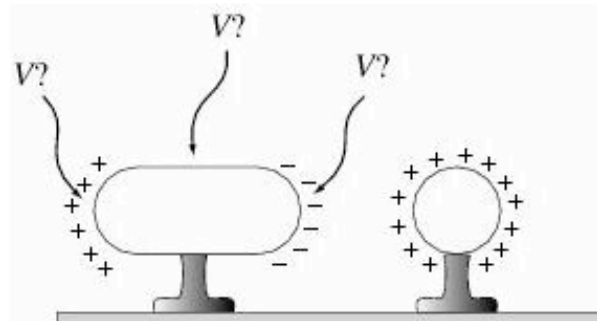
Correct?  
☐

Correct?  
☐



# Create student view of lecture

1. A charged object is brought near an uncharged metal object. Negative charges accumulate on the side of the uncharged object nearest to the charged sphere, positive charges on the opposite side. On the uncharged metal object, the potential is



1. largest on the positive side
2. largest on the negative side
3. largest in the middle
4. the same everywhere

Answer

2. A cylindrical piece of insulating material is placed in an external electric field, as shown. The net electric flux passing through the surface of the cylinder is



# Assignments: upload problem sets

READING LECTURES ASSIGNMENTS FORUMS NEWS HANDOUTS

Courses > VU Course > Assignment > Problem Set 1

Add questions, add a URL or a file to the assignment. Upload a solution file or link a solution URL to this assignment

**Name:**

Problem Set 1

**Category:**

Problem Set 

Edit category

**Link Type:**

No link [Change](#)

**Issue Date:**

Feb 1 2003 Time: 9 : 00 am

**Due Date:**

☐ In Class

☒ Take Home

Feb 11 2003 Time: 9 : 00 am

**TimeZone:**

Eastern Standard Time

**Solution Link:**

No solution [Change](#)

**Solution Issue Date:**

Feb 3 2003 Time: 1 : 35 am

**Questions:**

☐ 1: 5

☐ 2: 3

# Grade book: database of students grades

[READING](#) [LECTURES](#) [ASSIGNMENTS](#) [FORUMS](#) [NEWS](#) [HANDOUTS](#)

[Courses](#) > [VU Course](#) > [Assignment](#) > [Problem Set 1](#) > **Grade**

Select the students to grade. Select the question to be graded. Enter grade, comments and click "Save" X

**Name:**

**Student ID:**


**Sections:** ☐ Unsectioned students


**Question No:** 1   Maximum Grade: 5


**Found 1 students matching description.**


Name	Student ID	Grades	Comment
<a href="#">Lisa Simpson</a>	11112222	<input type="text" value="5"/>	<input type="text"/>


# Face book: connects all elements of course


 Miki Artiga I thought Lenz' law was the most interesting part since it is not something I would have deduced a priori, but the explanation using conservation of energy makes perfect sense that the magnetic field should have such a simple effect.  
 4/1/2003 9:04:51 0 / 1 pm


 Mark Riddell Ex changes direct greater detail/c produce electric


 Javier Valle I do charge separati there must be a have to thus ex confused!


 Lisa Simpson I ha get the director all the figures in because there i 33.3, why does increases when the magnetic fi toward R? And eddy currents v


 William Olson I about the effect figure out what types of things can confusion



**Lisa Simpson**

F11112222

lsimpson@fas.harvard.edu

**Class:** 2004  
**Major:** economics  
**Registered on:** 2/2/2003  
**PRS Unit ID:** 0248  
**Final grade:** B


Laboratory 8 Tue 1:00:pm  
 Section 5 Wed 4:00:pm

**Forums:** 4 posts  
**Email:** 36  
**No. of self-tests:** 1 self-tests  
**Reading FAQs:** 1


RA	CT	PT	L	PS	HE	OT	FE
6/6	1/1	2/2	9/10	40/40	20/35	5/5	39/60
4/6	5/6	2/2	9/10	28/35	14/35	15/15	
5/6 *	5/6	0/2		35/35	25/35	18/18	
5/6 *	2/3	2/2	9/10	35/35*			
5/6 *	6/9	2/2	10/10	35/35			
5/6 *	7/8	0/2		35/35			
6/6	3/4	2/2		35/35			
6/6 *	5/9	2/2		35/35			
5/6 *	9/9	2/2					
6/6	8/11						
6/6							
5/6 *	5/5						
6/6	10/10						
6/6	8/9						
6/6	10/10						
6/6	7/7						
6/6							
6/6	11/11						
6/6	9/9						
6/6	8/8						
6/6	13/13						
119/126	132/148	14/18	37/40	278/285	59/105	38/38	39/60
94%	89%	78%	93%	98%	56%	100%	65%

RA: Reading assignments; CT: ConceptTests; PT: Pretest; L: Laboratory; PS: Problem Set; HE: Hour Exam; OT: Online Test; FE: Final Exam;


# Email: priority listed and FAQ




Miki Artiga I thought Lenz' law was the most interesting part since it is not something I would have deduced a priori, but the explanation using conservation of energy makes perfect sense that the magnetic field does such a simple effect.




Mark Riddell Explain why the magnetic field changes directions in Figure 33.7. Also, ed because there was not much a 33.9, why does it say that the magnetic flux increases when the magnet is moved toward it? And part b of the eddy currents was also confusing!



Javier Valle I don't understand how charge separation is affected. I think there must be a force on the charges to thus exert a force on the charges!



Lisa Simpson I had difficulty with getting the direction of the current all the figures in 33.7. Also, ed because there was not much a 33.9, why does it say that the magnetic flux increases when the magnet is moved toward it? And part b of the eddy currents was also confusing!



William Olson I found that the magnetic field about the effects of moving charges figure out what the patterns are types of things work. This made very confusing.

4/1/2003 9:04:51 0 / 1 pm

ILT: Answer email

From: Lisa Simpson <lsimpson@fas.harvard.edu> (relink)

To: Eric Mazur <emazur@fas.harvard.edu> Brendan Connors

Received: Mon, 2 Jun 2003 00:50:38 -0400

Subject: RE: Office Hours

Dear Professor Mazur,

Thank you so much for your response. I would love to have met up with you, but as soon as my finals were over I left for San Diego. In just two days I will be heading off to Argentina for the summer to begin an internship with the NGO Medicos Del Mundo Argentina.

Now that the class has drawn to a close, I'd like to express my appreciation for Physics 1B. While the class does require a serious commitment, in the end I have come out with a solid understanding and appreciation for the E/M that you have taught us. Your teaching style has given us concepts rather than merely equations, and we've learned how to apply fundamental principles to virtually any situation. Too many classes make the mistake of teaching students how to answer questions, rather than teaching students the concepts, and letting the answers flow from there. For that, I am very grateful.

Thank you again for agreeing to write a letter of recommendation for me. I will send all of the information to you tomorrow morning. The letter doesn't need to be back to the House office until the end of the month. I hope that leaves enough time for you. I apologize that I couldn't get these materials to you sooner. Included you will find 1) A resume, 2) A waiver form, 3) A brief description of my interest in medicine and my plans for the future

Affects Grade: ☐ Message does not require response

RESPONSE

To: Lisa Simpson <lsimpson@fas.harvard.edu> (edit)

Cc: (separate emails with ',')

Subject: Re: RE: Office Hours

Dear Lisa,

Edit or copy over FAQ response:

RA not saved

Please post on forum

no CT scores

Some CT points missing

Lab 1 grade missing

waiting on a problem set grade

Missed CTs due to anti-war walkout

PS extension

RA change on 4/21

Online test retake

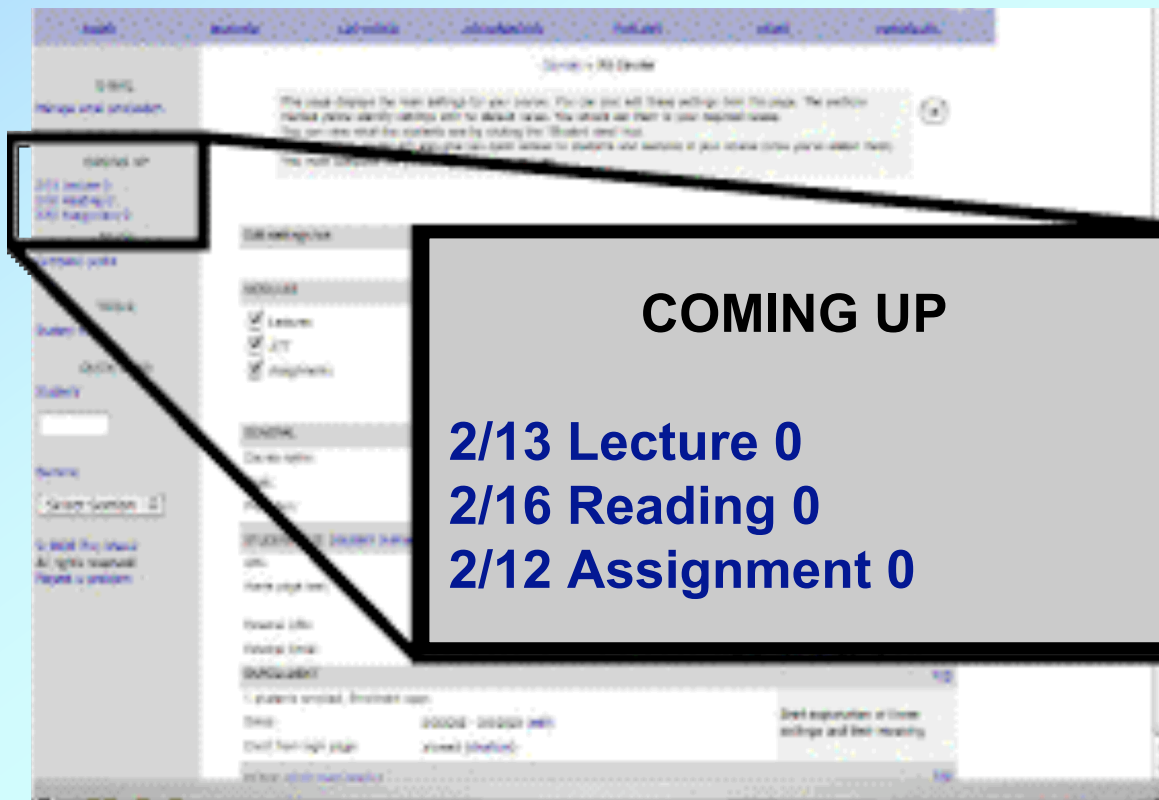
Online Test 1

Problem set #9 - optional

No more availability during Reading Period

Solns to online tests

# ***Calendar-based reminders: students & staff***





# *Clone course: saves time & great template*

READING   LECTURES   ASSIGNMENTS   FORUMS   NEWS   HANDOUTS

[Courses](#) > Clone Courses

New course name:

New course description:

Select information to copy

- ☒ JiTT reading assignments
- ☒ Lectures and ConcepTests
- ☒ Assignments
- ☒ Sections
- ☐ Staff
- ☐ Students
- ☒ Handouts
- ☒ Forum

## ***Essential Elements***

- ▶ **Reading (before class)**
- ▶ **Participating (in class)**
- ▶ **Problem solving (after class)**
- ▶ **Appropriate testing/assessment**
- ▶ **Technology Support - Interactive Learning Toolkit**



# ***Acknowledgments***

**NSF** Distinguished Teaching Scholar Award

**DEAS** Information Technology Group

**ASA** Assessment of Student Achievement in Undergraduate Education

**Mazur Group website (papers/talks):**

<http://mazur.deas.harvard.edu/>

# Resources

- ▶ **Peer Instruction: A User's Manual**  
(Prentice Hall, 1997)



- ▶ **Galileo Website:** <http://galileo.harvard.edu/home.html>
- ▶ **Interactive Learning Toolkit:**  
<http://www.deas.harvard.edu/galileo>
- ▶ **Just In Time Teaching** <http://www.jitt.org>
- ▶ **Assessment techniques: FLAG (Field-tested Learning Assessment Guide)** <http://www.flaguide.org>