Peer Instruction

Experiences from a course in Basic Mechanics

Fredrik Lundell

Associate professor, KTH Mechanics

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Fredrik Lundell

- **Associate professor, KTH Mechanics**
  At KTH since 1993 (MSc -98, PhD 2003, Associate 08)
  (One year in Japan and one year in France)

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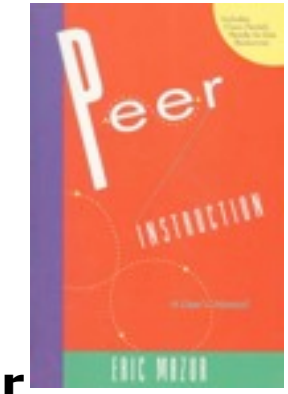
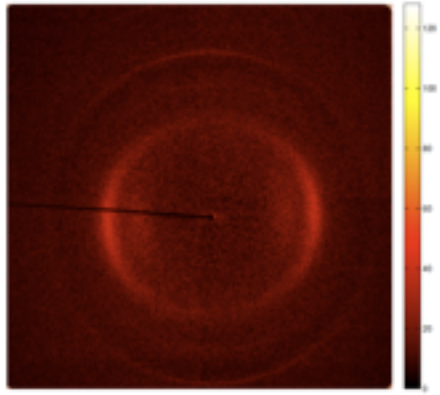
- Taught at KTH since 1994.



- Addicted to **”Peer Instruction”** since spring 2011
- **Teacher of the year** at KTH 2011, **Åforsks price for outstanding contributions to engineering education** 2012
- Research on **fluid mechanics for biomaterial procesing**



The situation

You are a teacher. You get in touch with a method that is *a lot* better than the one you and your collegues is using. You and your collegues have invested considerable time and effort in perfecting ”your” method and your collegues do not want to switch to the new method.

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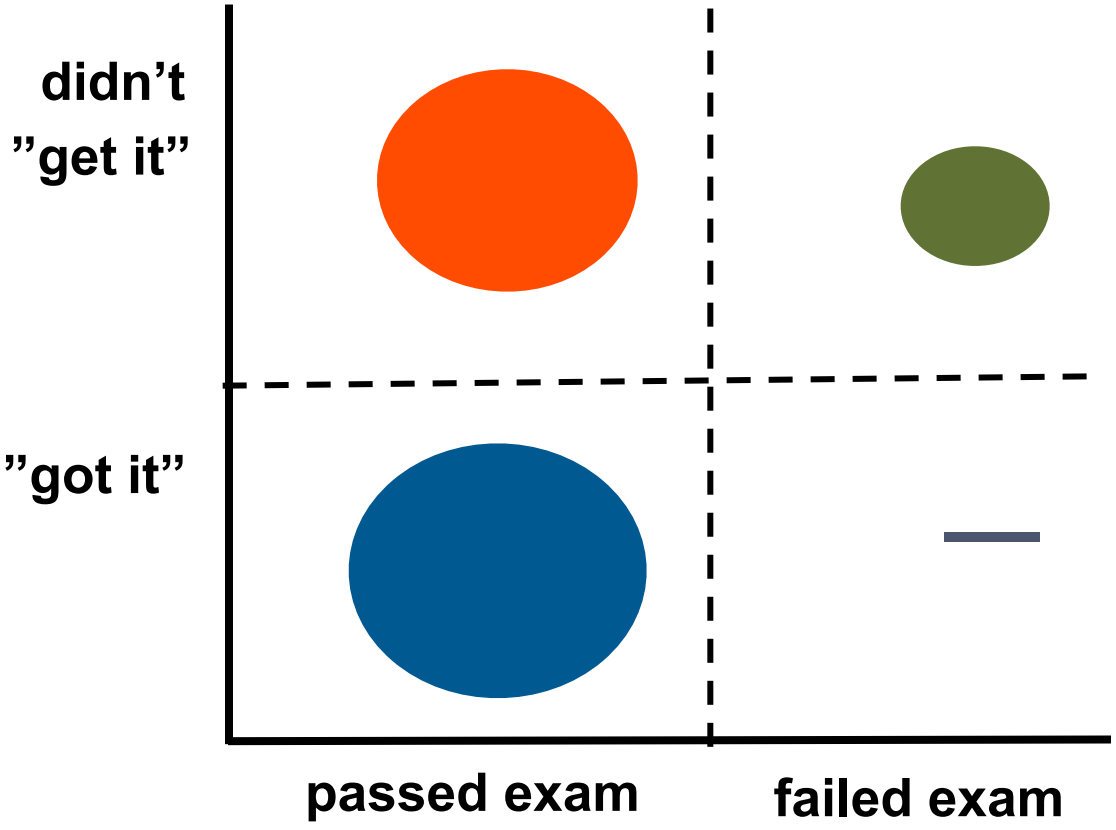
Swedish:
MD: läkare
teacher: lärare

Issue with my teaching

KTH Teknikvetenskap



Conceptual understanding

- Not just reproduction of known solutions to known problems
- Being able to explain what they do and why
- Deeper working disciplinary knowledge

See for instance Mazur, E. (1997) *Peer Instruction*, and Kember & McNaught (2007) *Enhancing University Teaching.*

A student perspective

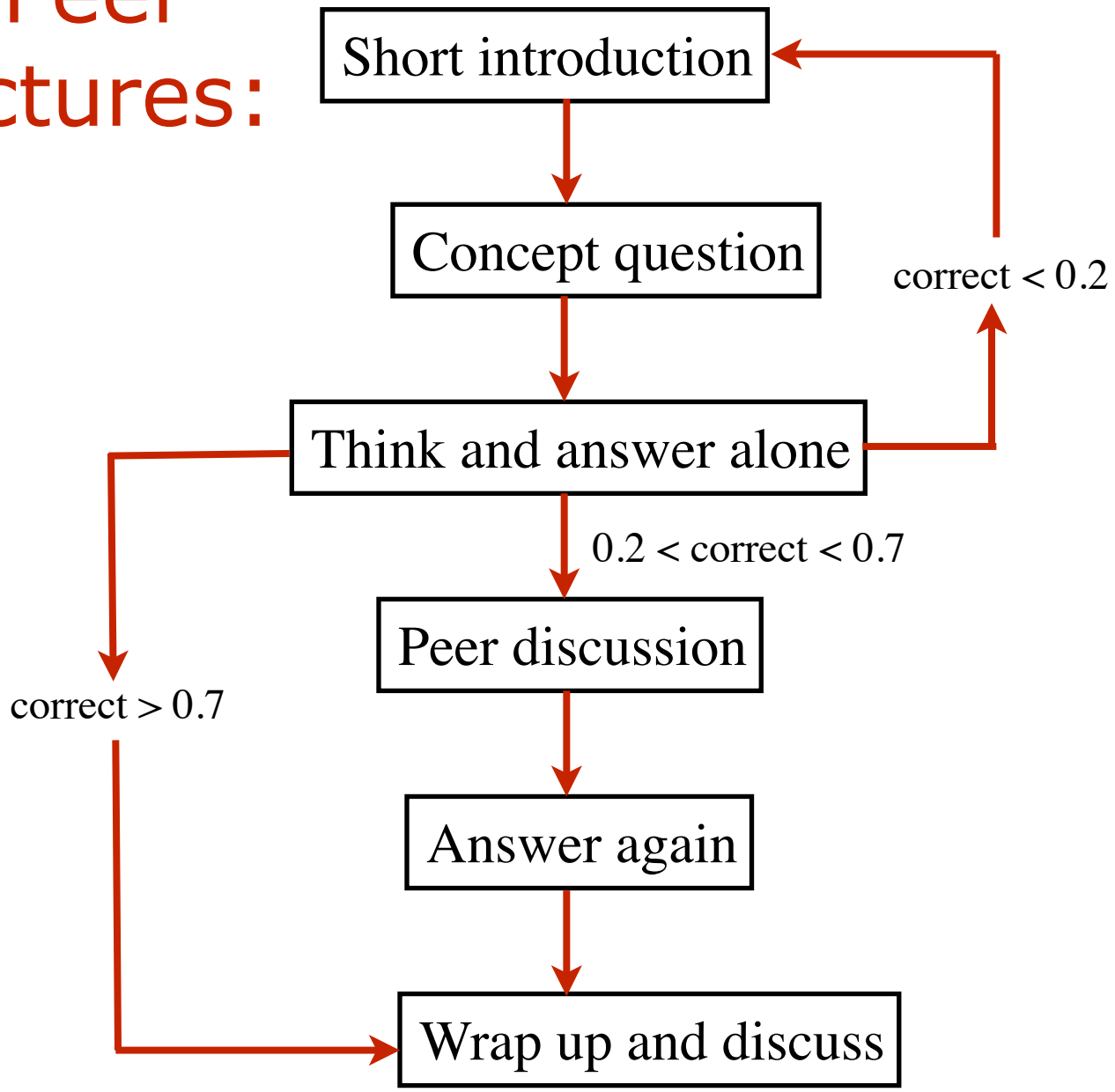
”When working on the previous exams, I notice that your exams are on a ”higher level” than the ones by other esaminers: your problems vary a lot. The issue is that I, as a student, cannot learn how to solve certain problems and demonstrate this at the exam. Can you please make the exam look more like the ones by the other teachers?”

Email from worried student day before the exam

The basic mechanics course

- 30 h lectures, 15 h recitations
- 100+ students
- Two written exams: theory (derivations)+problemsolving
- Difficult course according to students

Flow chart for Peer Instruction Lectures:



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Before the teacher starts

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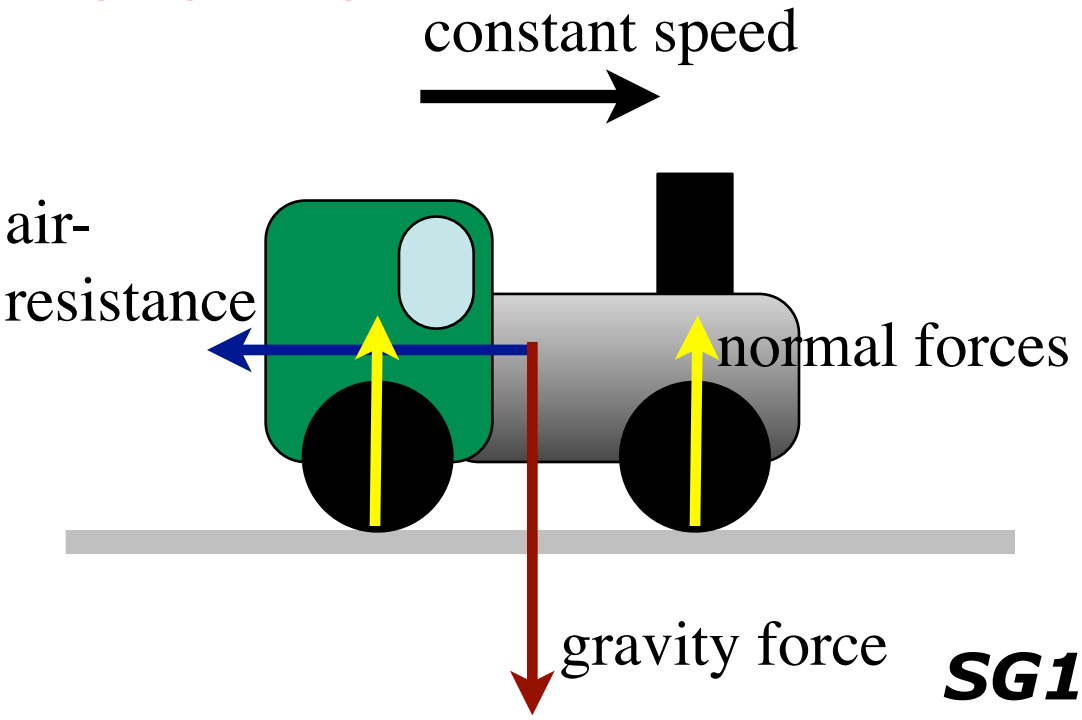
Concept: acceleration and total force



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What is the direction of the friction force on the driving wheels?

1. forward
2. backward

SG1102 2011:

	Before PD	After PD
forward	**49%**	**85%**
backward	51%	15%

Intense discussions

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Concept: *Work U*

$$\mathrm{d}U = \mathbf{F} \cdot \mathrm{d}\mathbf{r}, \qquad U = \int_{\mathbf{r}_1}^{\mathbf{r}_2} \mathbf{F} \cdot \mathrm{d}\mathbf{r}$$

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Raise up:

	Before PD	After PD
>0	43%	31%
<0	**35%**	**45%**
=0	17%	16%
Not well defined	5%	8%

Sit down:

	Before PD	After PD
>0	**70%**	**95%**
<0	30%	5%
=0	0%	0%
Not well defined	0%	0%

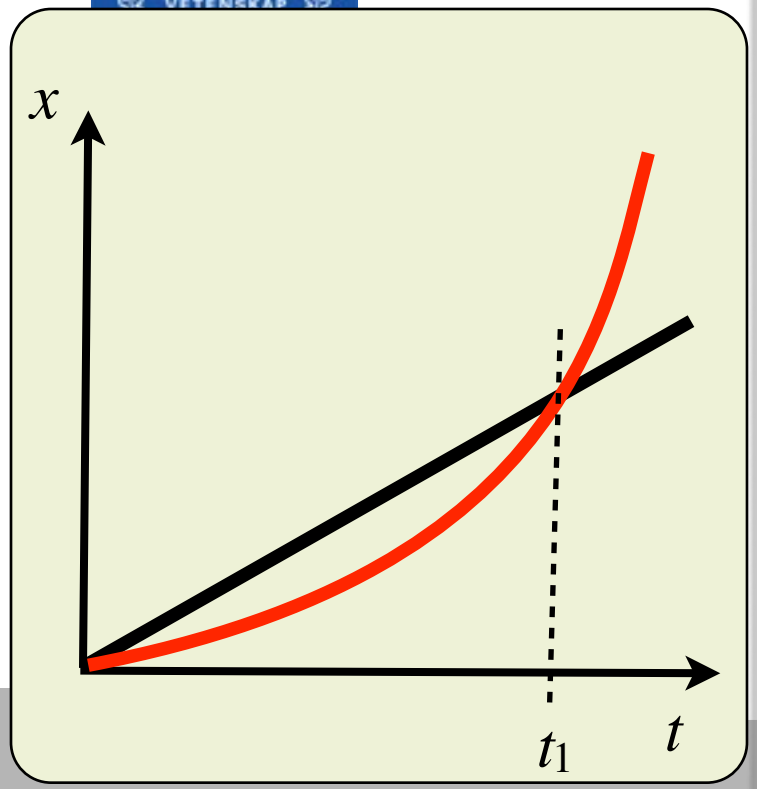
The work U performed by gravity on your head as you rasied was:

1. >0
2. <0
3. =0
4. Not well defined

Concept: *Speed and acceleration*

first derivative, inclination: **second derivative, curvature:**

$$v = \dot{x} = \frac{\mathrm{d}x}{\mathrm{d}t}, \qquad a = \ddot{x} = \frac{\mathrm{d}^2x}{\mathrm{d}t^2}$$



Two trains run on parallell tracks according to the graph. What is true?

1. Both trains have the same velocity at t_1.
2. Both trains increase their speed before t_1.
3. Both trains have the same velocity at some instance before t_1.
4. Both trains have the same acceleration at some instance.

Concept: *Speed and acceleration*

first derivative, inclination: **second derivative, curvature:**

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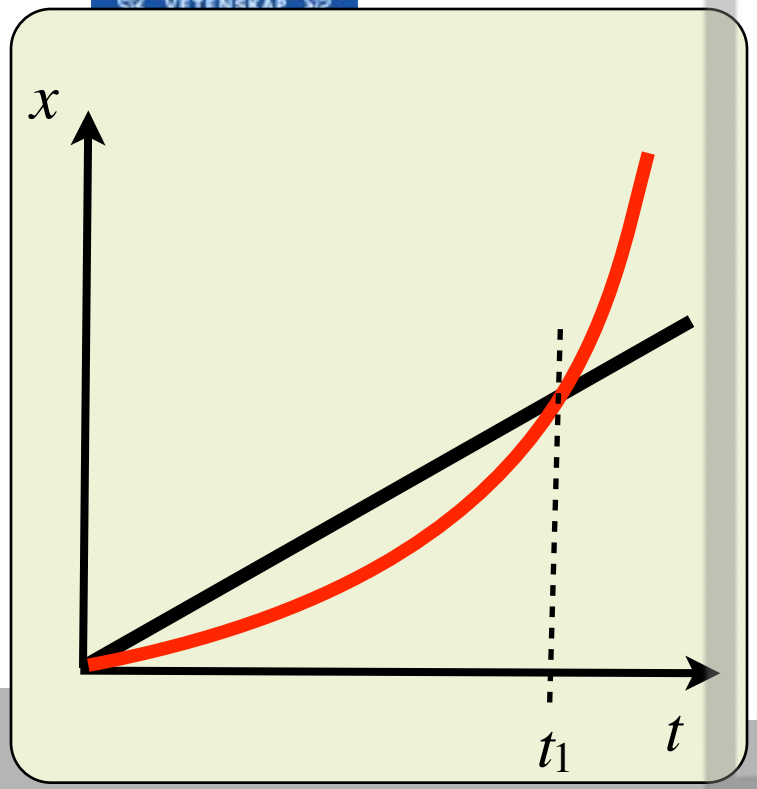

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SG1102 2011:

	Before PD	After PD
1	24%	14%
2	5%	4%
3	60%	77%
4	11%	5%

An elevator is moving upwards with constant speed, ignore friction

What is true about the force in the wire in which the elevator hangs?

1. The wire force is bigger than the weight of the elevator.
2. The wire force is equal to
3. The wire force is smaller
elevator.
4. The wire force is bigger t
elevator plus a force from th
5. Constant speed->forces
moves upwards because the

SG1102 2012:

	Before PD	After PD
1	35%	2%
2	**29%**	**87%**
3	1%	0%
4	8%	1%
5	27%	10%

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Result on the concept questions during a course in basic mechanics

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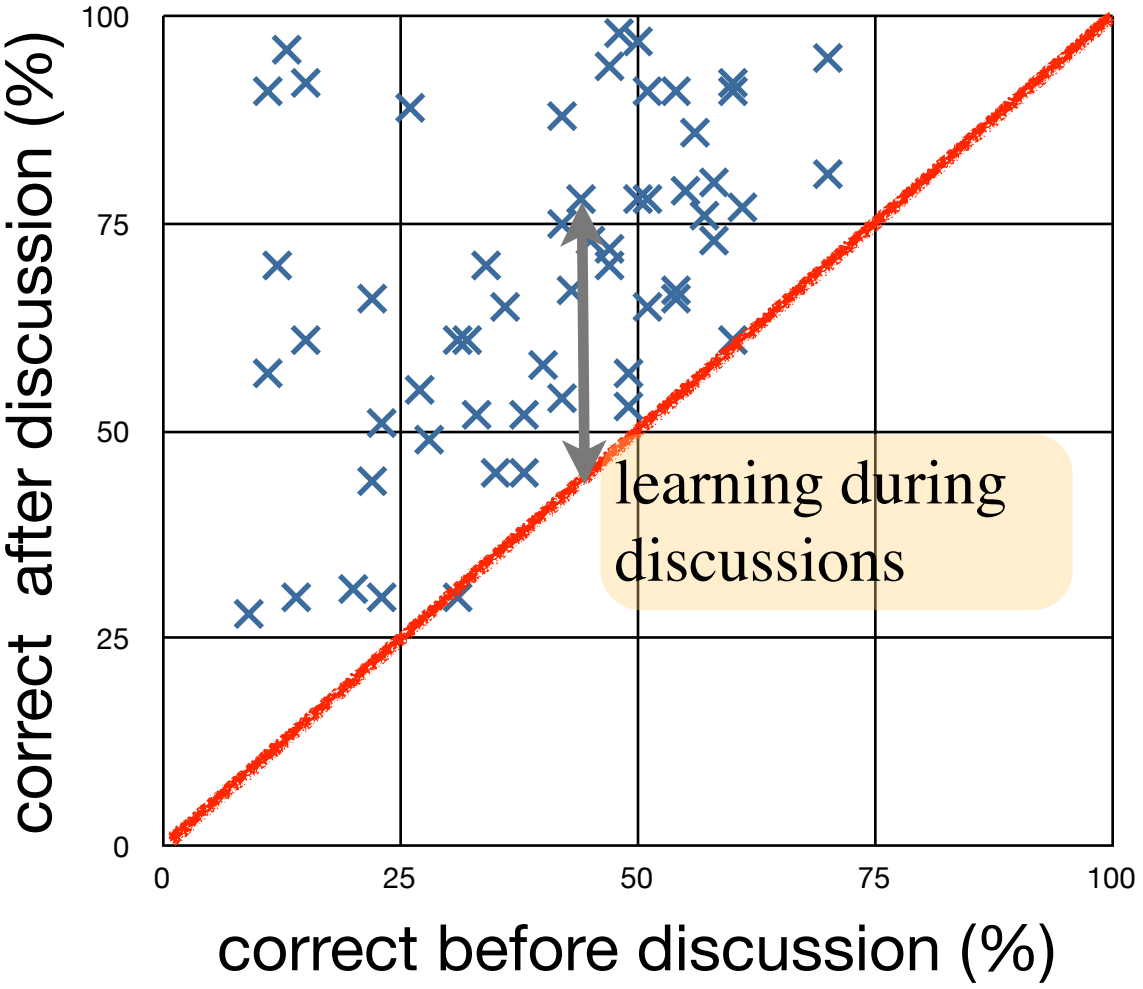

Problemsolving exam results, SG1102

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	OPEN (Lundell)	**Control group (same exams)**
Spring 2010 (No PI)	P: 71% ≥C: 37%	P: 71% ≥C: 28%
VT 2011 (PI in Open)	**P: 86%** **≥C: 41%**	P: 59% ≥C: 20%
VT 2012 (PI in Open)	**P: 73%** **≥C: 46%**	P: 49% ≥C: 30%

Theory exam results, SG1102

	OPEN (Lundell)	**Kontrollgrupp**
Spring 2010 (No PI)	P: 78% ≥C: 56%	P: 67% ≥C: 41%
Spring 2011 (PI in Open)	**P: 92%** **≥C: 65%**	P: 60% ≥C: 34%
Spring 2012 (PI in Open)	**P: 97%** **≥C: 82%**	P: 72% ≥C: 52%

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Prereading task, SG1102

Name:_____

Civic number:_____ Lecture number:_____

Quantities introduced in this chapter:

Symbol	Name	Vector or scalar?

Describe what the direction and length of the vector quantities represent:

Formulas derived in this chapter. Give name (if existing), equation and whether the relation is general or the solution of an example:

This is something I still don't understand in this chapter:

Student comments:

"Fredrik's approach before and during the lectures have been great!"

"Fun lectures, but it is hard to learn real examples based on logical thinking when asnwering the questions. However, one doesn't sleep during the lectures so it is still more efficient than traditional. After all, one should go to the problem solving sessions in order to learn hot to solve problems."

"One learnt a lot on the lectures, but it was hard to take notes."

"Excellent lectures!"

"[...] Fredrik's lectures were far from boring, but sometimes they felt shallow - as if the need for everyone to learn the basics turned everything that is needed for deeper understanding of the theory (and applications of it!) into homework for the interested. It must be a hard balance [....]"

"I did not learn a lot on on the lectures (still joined 13 out of 15, my comment), but I noticed that everyone else learned a lot."

"... however, the clickers dominate to much and they did not gave a lot in return...."

More inspiration:

- *Peer Instruction* by **Eric Mazur**
- **www.peerinstruction.net**: Community for Peer Instruction users (2500 members!)
- http://www.cwsei.ubc.ca/ , initiative by **Carl Wieman** (Nobel laureate 2001), a lot of evidence-based material
- **www.flaguide.org:** Field-tested Learning Assessment guide: examples on lecture activities with documented effects

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