

OUTLINE

- Our Courses and Our Students
- Traditional JiTT
- Worked-Examples JiTT Extension



Our Courses and Our Students

- Every student takes two semesters of calculus physics, regardless of major
- The student body is chosen on a variety of criteria, not all academic
- Students must graduate in four years
- Student time is divided into academics, military training



LEARNER CENTERED INSTRUCTION Challenge and Support

"To be actively involved, students must engage in such higher-order thinking tasks as analysis, synthesis, and evaluation. Within this context, it is proposed that strategies promoting <u>active</u> <u>learning</u> be defined as <u>instructional activities</u> <u>involving students in doing things and thinking</u> <u>about what they are doing.</u>"

(ref. http://www.ntlf.com/html/lib/bib/91-9dig.htm)



- Emphasis is on using communicating knowledge effectively to address enduring and emerging issues and problems in real-life contexts.
- Assessment is used to promote and diagnose learning.
- Emphasis is on generating better questions and learning from errors.
- Professor's role is to coach and facilitate.
- Professor and students evaluate learning together.



scott simkins and mark h. maier

Traditional JiTT

just-in-time teaching

2009

Across the Disciplines, Across the Academy Pre-Class WarmUp Assignments **Posted and Due just before class** •

- Designed as a Diagnostic
- In-class activity based on responses





1999



Worked-Examples JiTT Extension

- New material is introduced via carefully crafted, expert version of examples of problems.
- Students analyze the worked out examples and try to construct a rudimentary version of the conceptual knowledge.
- In-class time is spent in elaborating on the selfconstructed knowledge and firming it up. Examples are discussed and extended with practice workouts, underlying concepts are explained.



EXAMPLE 2.4 Motion with Two Objects: Speed Trap!

A speeding motorist zooms through a 50 km/h zone at 75 km/h (that's 21 m/s) without noticing a stationary police car. The police officer heads after the speeder, accelerating at 2.5 m/s². When the officer catches up to the speeder, how far down the road are they, and how fast is the police car going?

INTERPRET We interpret this as *two* problems involving one-dimensional motion with constant acceleration. We identify the objects in question as the speeding car and the police car. Their motions are related because we're interested in the point where the two coincide.

DEVELOP It's helpful to draw a sketch showing qualitatively the position-versus-time graphs for the two cars. Since the speeding car moves with constant speed, its graph is a straight line. The police car is accelerating from rest, so its graph starts flat and gets increasingly steeper. Our sketch in Fig. 2.10 shows clearly the point we're interested in, when the two cars coincide for the second time. Equation 2.10,



FIGURE 2.10 Our sketch of position versus time for the cars in Example 2.4.

 $x = x_0 + v_0 t + \frac{1}{2}at^2$, gives position versus time with constant acceleration. Our plan is (1) to write versions of this equation specialized to each car, (2) to equate the resulting position expressions to find the time when the cars coincide, and (3) to find the corresponding position and the police car's velocity. For the latter we'll use Equation 2.7, $v = v_0 + at$.

EVALUATE Let's take the origin to be the point where the speeder passes the police car and t = 0 to be the corresponding time, as marked in Fig. 2.10. Then $x_0 = 0$ in Equation 2.10 for both cars, while the speeder has no acceleration and the police car has no initial velocity. Thus our two versions of Equation 2.10 are

 $x_{\rm s} = v_{\rm s0}t$ (speeder) and $x_{\rm p} = \frac{1}{2}a_{\rm p}t^2$ (police car)

Equating x_s and x_p tells when the speeder and the police car are at the same place, so we write $v_{s0}t = \frac{1}{2}a_pt^2$. This equation is satisfied when t = 0 or $t = 2v_{s0}/a_p$. Why two answers? We asked for *any* times when the two cars are in the same place. That includes the initial encounter at t = 0 as well as the later time $t = 2v_{s0}/a_p$ when the police car catches the speeder; both points are shown on our sketch. *Where* does this occur? We can evaluate using $t = 2v_{s0}/a_p$ in the speeder's equation:

$$x_{\rm s} = v_{\rm s0}t = v_{\rm s0}\frac{2v_{\rm s0}}{a_{\rm p}} = \frac{2v_{\rm s0}^2}{a_{\rm p}} = \frac{(2)(21 \text{ m/s})^2}{2.5 \text{ m/s}^2} = 350 \text{ m}$$

Equation 2.7 then gives the police car's speed at this time:

$$a_{\rm p} = a_{\rm p}t = a_{\rm p}\frac{2v_{\rm s0}}{a_{\rm p}} = 2v_{\rm s0} = 150$$
 km/h

ASSESS Make sense? As Fig. 2.10 shows, the police car starts from rest and undergoes constant acceleration, so it has to be going faster at the point where the two cars meet. In fact, it's going twice as fast—again, as in Example 2.2, that's because the police car's position depends quadratically on time. That quadratic dependence also tells us that the police car's position-versus-time graph in Fig. 2.10 is a parabola.

Wolfon, Essential Physics, 2007



JiTT Warmup



- If the axes on Figure
 2.10 included units,
 what would those
 units be?
- 2. If the axes on Figure 2.10 included units, could one determine the speed of the car from the graph? How?



Pre-Class Worksheet

E2.3_Q1: Equation 2.7, $v = v_0 + at$, relates velocities and accelerations (for constant acceleration.) State in words the algebraic steps that take you from equation 2.7 to equation 2.10.

E2.3_Q2: In Example 2.2 you obtain the answer using equation 2.11. State in words the algebraic steps that take you from equation 2.10 to equation 2.11.

E2.4_Q1: What is the expression for the position x_s of the speeder car at time t if it is moving in a straight line at constant velocity v_s ?

E2.4_Q2: If in this example, instead of the speeder and the policeman scenario we had two dragsters starting from rest with different accelerations, racing over a ¹/₄ mile straight track, how would you determine how far behind is the slow car when the winner reaches the finish line? Which equations would you use and what would you do with them? Answer in words.



Benefits

•The pre-class assignment create a structured study environment.

• Students monitoring their own learning processes, develop metacognition skills.

• Daily practice reduces anxiety and reduces test prep time.

Mandatory daily work:

- Helps with study time management.
- Adds value to in-class time.



Research Underpinnings

COWYAAPT, April 20, 2013

Monday, April 22, 2013



Cognitive Load

History - From Miller to John Sweller Cognitive Load Theory to Instructional Design

Why Some Material is Difficult To Learn

Working Memory vs Long Term Memory

Cognitive Load

Element Interactivity

Task: Plot P(x.y)

- I. Algebraic vs Geometric System
- 2. P(x,y) refers to point in both systems
- 3. x refers to location x on x-axis
- 4. y refers to location y on y-axis
- 5. Draw a line from x perp to x-axis
- 6. Draw a line from y perp to y-axis
- 6. The meeting of point of lines is P(x,y)



Cognitive Load

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Why Some Material is Difficult To Learn

Working Memory vs Long Term Memory

Cognitive Load

SHORT TERM WORKING MEMORY
limited to about seven information units
engaged in processing instructional material
encoding it into long term memory

LONG TERM MEMORY •essentially unlimited store of knowledge •factual data •processing instructions

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Cognitive Load

COGNITIVE LOAD•quantity and complexity of elements to process•instructional design influences both

INTRINSIC LOAD•quantity and complexity are interrelated•minimally influenced by instructional design

EXTRANEOUS LOAD•how information is presented•at the heart of instructional design

COWYAAPT, April 20, 2013

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Exploring Examples before theory

reduces cognitive load engages principle-based learning rather than rule-based learning discriminates between relevant and irrelevant features of rules calls attention to the steps in problem solving assists in schema formation and skill building encourages more self-explaining than straight problem solving avoids the illusion of understanding

Example study works best when combined with prompted self-explanations



Self-Explanation

History - Classic Study 1989 by Michelene Chi and colleagues - on-going

What is self-explaining?

Types of self-explanation

Prompting self-explanation

Trainable learning activity where students
generate fill-in missing information
integrate information within the study material
integrate new information with prior knowledge
monitor and repair faulty knowledge

Good learners tend to be •principle-based explainers •anticipative reasoners

Self-explaining can be successfully prompted or trained rather than spontaneously generated with similar learning benefits



Self-Explanation

History - Classic Study 1989 by Michelene Chi and colleagues - on-going

What is self-explaining?

Types of self-explanation

Prompting self-explanation

We would like the students to know:
what are the consequences of an action
when the action is applicable
what is the relationship of actions to goals
what is the relationship of goals and actions to principles

Explanation Statements
Interpretative
Monitoring
Mathematical Elaborations
Strategic



Self-Explanation Prompts

a. Justification-based Prompts (Conati & VanLehn, 2000) What principle is being applied on this step?

This choice is correct because...

What is the justification for this step? Why is it correct? What law, definition, or rule allows one to draw that conclusion?

b. Meta-cognitive Prompts (Chi, et al., 1994)What new information does each step provide for you?How does it relate to what you've already seen?Does it give you a new insight into your understanding of how to solve the problems?Does it raise a question in your mind?

c. Step-focused Prompts (Hausmann & Chi, 2002)What does that step mean to you?Do you have any more thoughts about that step?Could you restate or summarize that step in your own words?So, specifically, what else does this step tell us?



Pre-class Assignment

- WarmUp
- Pre-Instruction Worksheet

In-Class Follow Up

- Discussion of examples
- Mini-lecture
- In-class worksheets

Post-instruction

Graded homework







Benefits - Student Perspective

- The pre-class assignment create a structured study environment.
- Students monitor their own learning processes and develop metacognition skills.
- Daily practice helps with time management, reduces anxiety and test prep time.



Benefits - Instructor Perspective

- Students prepare for the lesson
- Instructor aware of the bottlenecks
- Improved classroom climate



Current CPER Projects

- Stand-Alone Examples NSF supported project
- Student and Instructor Preparation
- Monitoring Student Engagement Mobile Technology Project

Monday, April 22, 2013



THANK YOU



Tell me and I forget. Teach me and I remember. Involve me and I learn.

-Chinese Proverb as quoted by Benjamin Franklin