岡山大学
MPコース・フォーラム
2006年9月2日

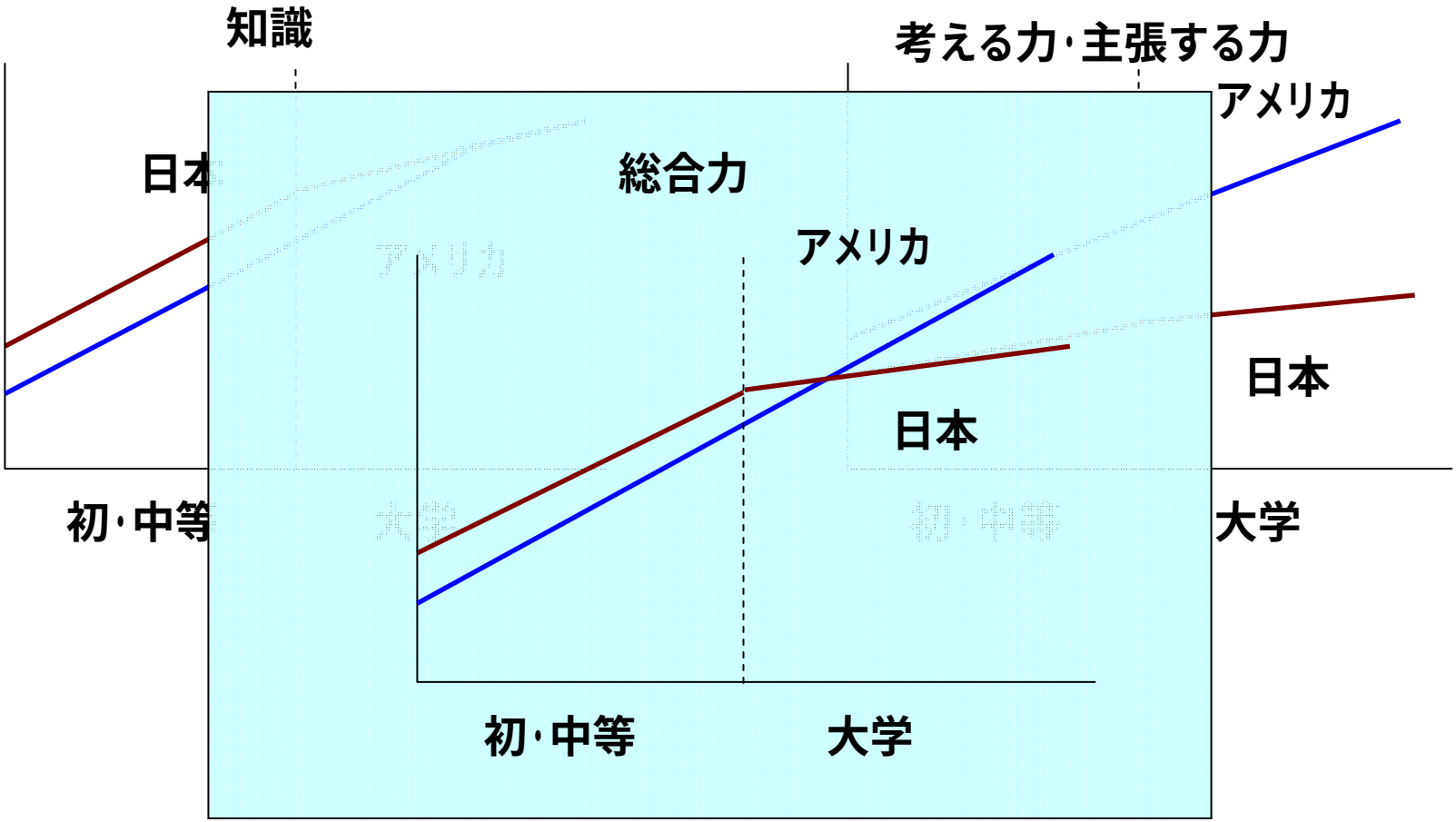
アメリカにおける教育と日本の科学教育

九州大学大学院理学研究院
小田垣　孝

教育との関わり

1964	BC		
1965		(京都大学)	
1966			
1967			
1968	MC		
1969			
1970	DC		
1971			数学
1972		桂高等学校	物理･化学
1973			
1974	OD	大阪工業大学	力学･物理学･微積分学
1975			
1976		摂南大学	物理学
1977			
1978			
1979	PD		
1980		ニューヨーク市立大学	(ＤＣ学生指導)
1981			
1982	AP		
1983		ブランダイス大学	数値計算法･統計力学･固体物理･
1984			計算物理
1985			
1986			
1987		ボストン日本人学校	数学
1988		中学･高校	
1989	P		
1990		京都工芸繊維大学	物理学･固体物理学･量子物理学
1991			物理学実験
1992			
1993	P		
1994		九州大学	統計力学･固体物理･量子物理学基礎･
1995			物理学入門など
1996			
1997			
1998			
1999			
2000			
2001			
2002			
2003			
2004		(理学研究院長･理学府長･理学部長)	
2005			
2006			

日米学生の比較



○何故か

○大学教育で何ができるか

初等･中等教育まで
さかのぼる必要

アウトライン

1. **はじめに**
2. He is doing what he wants to do.
3. Show and tell.
4. What do YOU think?
5. Are you doing physics?
6. I don’t think so.
7. **九州大学の取組**

He is doing what he wants to do.

ナーサリースクールから

Belmont Cooperative Nursery School


Kk Ll Mm Nn Oo Pp Qq Rr Ss Tt Uu Vv Ww Xx Yy

- ヘルパーの役割
  - 本を読んで聞かせる
  - 絵を描く補助
  - 工作の補助
  - 一緒に遊ぶ

ナーサリースクール

- 基本的に自由に過ごす
- 全体集会1日1回程度
- キンダーに入れるだけの集団生活ができるか
- 能力に応じて
- 個性を大切に

日本では：

- 同じことを同じようにすることが求められる
- 少数意見は認められない
- 個性が無視される

Show and tell.

キンダーガーテンから

Wellington School

Halloween Party

Show and Tell

Winn Brook School

キンダーガーテン

- 小学校に併設されている
- 入学年齢は、地域･個人で異なる
- 自分の主張ができるように
  - ･人前で話せる
  - ･自分の興味のあるものについて話させる
- 社会性の涵養
  - ･Thank you と言える
  - ･人の顔を見て話す
  - ･人が話しているときに割り込まない
  - ･ドアを後に続く人のために開けておく
- 合理的考えが尊重される
- 最先端の技術に触れさせる
  - ･２０年前にパソコンを使った図形の問題など

日本の幼稚園

- 同じ服装
- 規律が重んじられる
- 集団中心の行動
- 自由がない
- 均一化：意見の違いが認められない
- 合理性よりも規則

What do YOU think?

小 学 校 か ら

Winn Brook School Reopening Ceremony

Science corner

Reading corner

Cooking corner

ゆとりの時間：日本についての授業

ゆとりの時間：お別れのピザパーティー

小学校で

- 必ず**自分の意見**が求められる
- ディベート
  - 大統領選挙模擬投票
- 各学年のやるべき内容が決まっている：
  - できる子供はどんどん先にやる(飛び級あり)
- できる子の特別授業
- 先生の裁量が多い (ゆとりの時間)
- 校長と直接話す

日本では

- 指導要領通りの教育
  - 個人の能力を無視した教育
  - できる子は足踏みさせられる
  - 先生の裁量権が少ない
  - 視写の意味？
- 先に「知っている」ことができること
- 校長は生徒の訴えを聞かない
- 自己主張は嫌われる
- 「わかる」と言うことが教えられない

Are you doing physics?

高校物理から

等加速度運動

1) 等加速度直線運動
2) 自由落下
3) 鉛直投射
4) 水平投射
5) 斜方投射

B 等加速度直線運動

図4の滑走体の運動のように，加速度が一定である直線運動を **等加速度直線運動** という。

はじめの速度（**初速度**）が v_0〔m/s〕で，加速度が a〔m/s²〕の等加速度直線運動を調べよう。はじめの位置を原点Oとして x 軸をとり，t〔s〕後の位置Pの変位（座標）を x〔m〕，速度を v〔m/s〕とする（次ページ図16(a)）。$a>0$ の場合には，速度は毎秒 a〔m/s〕ずつ増すから，t〔s〕後には at〔m/s〕だけ増加して，次の式が成り立つ。

$$v=v_0+at \qquad (9)$$

したがって，v-t 図は傾きが a の直線になる。

t〔s〕後の変位 x〔m〕は，同図(b)の v-t 図を用いて求めることができる。t〔s〕間を短い時間 Δt〔s〕ごとの区間に分け，それぞれその間の平均の速度で進むと考えると，各区間ごとの変位（＝速度×時間）の大きさはそれぞれ図の細長い長方形の面積である。したがって，t〔s〕間の変位の大きさはこれらの長方形の面積の総和になり，Δt〔s〕をきわめて小さくとると，これは図の台形OPQRの面積になる。これが t〔s〕間の変位 x〔m〕に相当するから

$$x=\frac{v_0+v}{2}t=\frac{v_0+(v_0+at)}{2}t=\left(v_0+a\cdot\frac{t}{2}\right)t$$

したがって，次の式が得られる。

$$x=v_0t+\frac{1}{2}at^2 \qquad (10)$$

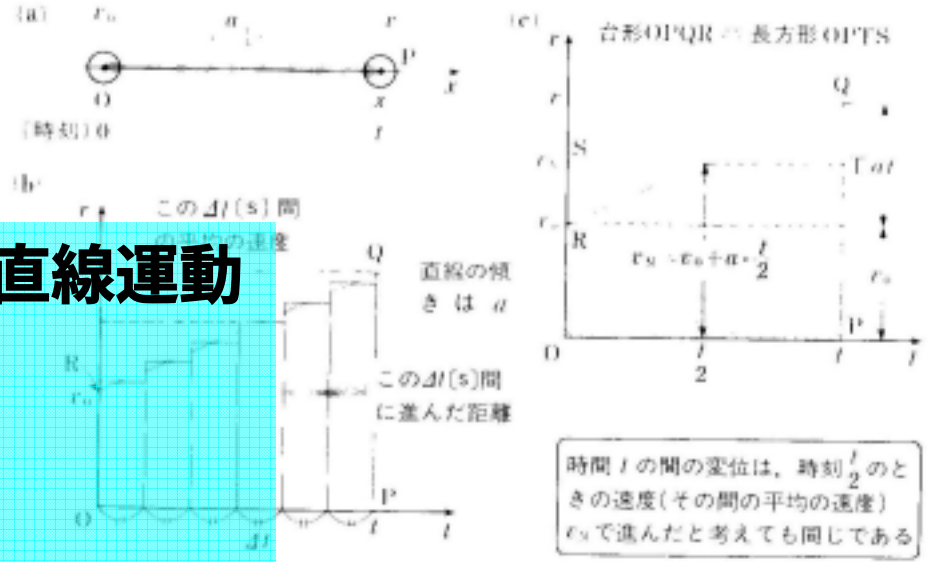


図16 等加速度直線運動 ($a>0$)

時間 t の間の変位は，時刻 $\frac{t}{2}$ のときの速度（その間の平均の速度）$v_0+\frac{1}{2}at$ で進んだと考えても同じである

また，(9)，(10)式から t を消去すると，変位とそのときの速度との関係として

$$v^2-v_0^2=2ax \qquad (11)$$

が得られる。

$a<0$ の場合には，v-t 図などは図17のようになるが，この場合にも(9)，(10)，(11)式が成りたつ。

問 10. 自動車が静かに動きだしてから一定の加速度で速

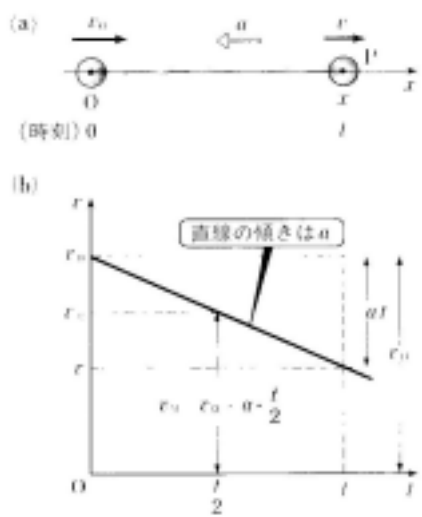


図17 等加速度直線運動 ($a<0$)

Uniformly accelerated motion is motion with constant acceleration. If the object starts moving from rest, the initial velocity is zero, and the expression for its acceleration becomes $v_f = at$. If an object is allowed to *fall freely* near the surface of the earth (its initial velocity is zero and no forces other than gravity act on it during its fall), the acceleration of the object remains constant and is independent of the mass of the object. The letter g is used universally for this acceleration. The value of g varies slightly from point to point on the surface of the earth. Unless told to do otherwise, in the MKS system use $g = 9.8$ m/s^2; in the English system use $g = 32$ ft/sec^2.

If an object is projected into the air in some direction other than the vertical, air resistance being negligible, the path is a parabola. The motion can be thought of as a combination of two separate motions: a horizontal motion in which the velocity remains constant and has the value of the horizontal component of the velocity with which it is projected, and a vertical motion due to gravity. If the object is projected horizontally, the vertical motion is the same as in free fall. You should memorize the following formulas, but be sure you memorize at the same time the situations for which each formula applies.

Motion with constant acceleration (starting from rest)

$v_{av} = v_f/2$		v_{av} = average speed
$v_f = at$	$(v_f = gt)$	v_f = final velocity
$s = \frac{1}{2}at^2$	$(s = \frac{1}{2}gt^2)$	a = acceleration
$v_f^2 = 2as$	$(v_f^2 = 2gs)$	t = elapsed time

If an object is projected into the air in some direction other than the vertical, air resistance being negligible, the path is a parabola. The motion can be thought of as a combination of two separate motions: a horizontal motion in which the velocity remains constant and has the value of the horizontal component of the velocity with which it is projected, and a vertical motion due to gravity. If the object is projected horizontally, the vertical motion is the same as in free fall. You should memorize the following formulas, but be sure you memorize at the same time the situations for which each formula applies.

$$v_f = v_i + at$$
$$s = v_i t + \tfrac{1}{2}at^2$$
$$v_f^2 = v_i^2 + 2as$$

Barron's SATII Physics より

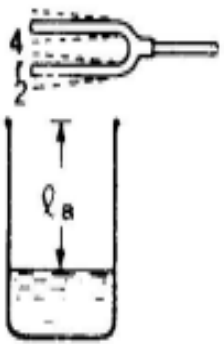
気柱の共鳴

VIBRATING AIR COLUMNS

Some musical instruments, such as organ pipes, produce sound by means of vibrating air columns. We can set the air column into vibration by blowing across or into one end of the pipe.

Closed Pipes

Another way to describe a vibrating air column is in terms of resonance. Imagine a narrow cylinder with some water at the bottom. This gives us an air column of length l_a. Since water is practically incompressible, the air in contact with the water cannot move down. This is, therefore, a closed air column. Imagine a tuning fork vibrating above the air column. Concentrate on the bottom prong of the fork. Its rest or equilibrium position is shown at *r*; its highest position at *4*; its lowest position during vibration at *2*. As the prong moves from *4* towards *2*, a compression forms at *r* and travels down the air column; when it reaches the water surface the compression is reflected. If the reflected compression reaches the prong just when it is at *r*, sending a compression in the direction away from the tube, the fork's vibration will be reinforced. The result is resonance between the vibrating tuning fork and air column—a loud sound is heard if the right amount of water has been poured in. How long should this air column be? The time required for the prong to go from *4* to *2* is one-half of the period of vibration. During this time the wave travels a distance equal to one-half of a wavelength (λ). But in this experiment this distance traveled was up and down the air column. Therefore $2l_a = \lambda/2$; or



$$\lambda = 4l_a$$

the length of the air column. By the time the wave is reflected by the water and comes back to the tuning fork the prong has gone back to *4* and has just reached *2* again. Again the reflected air wave

レンツの法則

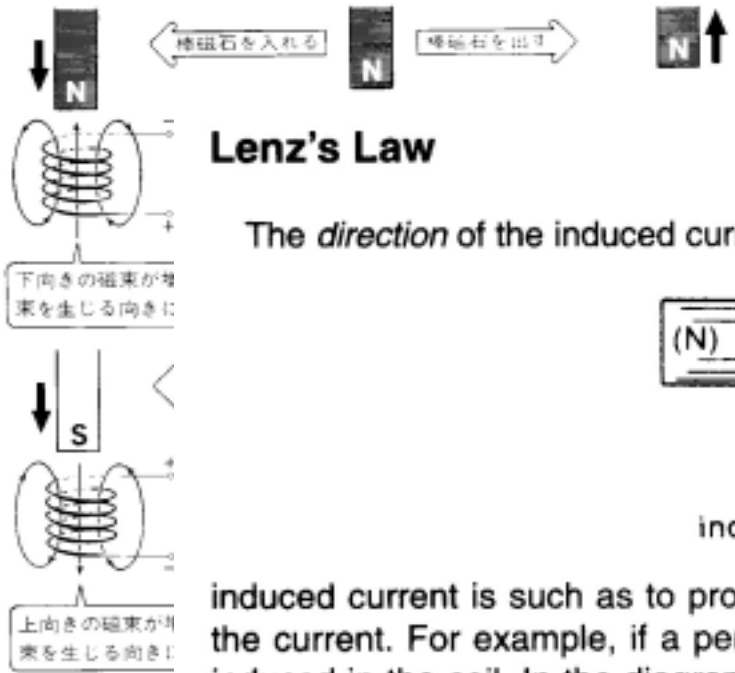


図 22 コイル

りするときに

このように，

磁誘導，生じ

いると，誘導

B レンツの

で，誘導起電

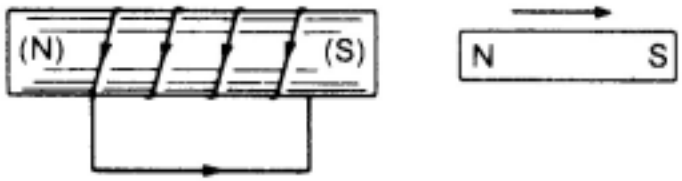
誘導起電力

加えられた磁

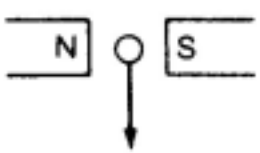
これを **レンツの法則**（レンツ：ロシア，1804～1865）という（1834）。

Lenz's Law

The *direction* of the induced current can be figured out by the use of *Lenz's law:* the direction of the induced current is such as to produce a magnetic field which will hinder the motion that produced the current. For example, if a permanent magnet is moved away from a stationary coil, an emf is induced in the coil. In the diagram shown, the motion of the magnet is opposed if the induced current produces an S-pole to attract the retreating N-pole. This will happen if the induced current has the direction shown. Of course, an N-pole will be produced simultaneously at the left end of the coil. If we have a single wire moving across a magnetic field, we can determine the direction of the current this way: In the diagram assume that the wire is perpendicular to the page and pulled towards the bottom edge of the paper. If the induced current is directed into the paper, the left-hand rule tells us that the magnetic field is weakened above the wire, strengthened below it (closer to you). This tends to push the wire toward the top edge of the paper, opposing the motion which produced the induced current. Therefore we guessed the direction of the induced current correctly: into the paper. Note that Lenz's Law is a special case of the law of conservation of energy.



Direction of
induced electron flow



Motion
of wire

高校物理から

日本では

- 様々なケースごとに公式を覚えさせる
- 複雑な状況にも適用して数値を出す
- 何が本質かが不明

アメリカでは

- 論理的に考えさせる
- Doing Physics:
  普遍的な法則からの現象の理解
- 複雑な状況は考えさせない

大学入学願書の例

FAMILY

Parent 1 (Last Family, First, Middle, Gender)

Living? ☐ Yes ☐ No (Date deceased .....)

Home address if different from yours

Home phone .....

E-mail .....

Occupation .....

Name of employer .....

Work phone .....

Work e-mail .....

College (if any) .....

Degree ..... Year .....

Graduate school (if any) .....

Degree ..... Year .....

Parents' marital status: ☐ married ☐ separated ☐ divorced (date .....) ☐ never married ☐ widowed

With whom do you make your permanent home? ☐ Parent 1 ☐ Parent 2 ☐ Both ☐ Legal Guardian ☐ Other relation

Legal guardian's name/address

Please give names and ages of your brothers or sisters. If they have attended college, give the names of the institutions attended, degrees, and approximate dates.

Parent 2 (Last Family, First, Middle, Gender)

Living? ☐ Yes ☐ No (Date deceased .....)

Home address if different from yours

Home phone .....

E-mail .....

Occupation .....

Name of employer .....

Work phone .....

Work e-mail .....

College (if any) .....

Degree ..... Year .....

Graduate school (if any) .....

Degree ..... Year .....

EXTRACURRICULAR, PERSONAL, AND VOLUNTEER ACTIVITIES (including summer)

Please list your **principal** extracurricular, community, and family activities and hobbies **in the order of their interest to you.** Include specific events and/or major accomplishments such as musical instrument played, varsity letters earned, etc. Check (✓) in the right column those activities you hope to pursue in college. **To allow us to focus on the highlights of your activities, please complete this section even if you plan to attach a résumé.**

Activity	Grade level at post-secondary (PS): 9 10 11 12 PS	Approximate time spent: Hours per week	Weeks per year	Positions held, honors won, or letters earned	Do you plan to participate in college?
	☐☐☐☐☐				☐
	☐☐☐☐☐				☐
	☐☐☐☐☐				☐
	☐☐☐☐☐				☐
	☐☐☐☐☐				☐
	☐☐☐☐☐				☐
	☐☐☐☐☐				☐

ACADEMIC HONORS

Briefly list or describe any scholastic distinctions or honors you have won since the ninth grade (e.g., National Merit, Cum Laude Society).

WORK EXPERIENCE

List any job (including summer employment) you have held during the past three years.

Specific nature of work	Employer	Approximate dates of employment	Approximate no. of hours spent per week

SHORT ANSWER

Please describe which of your activities (extracurricular and personal activities or work experience) has been most meaningful and why (150 words or fewer).

PERSONAL ESSAY

This personal statement helps us become acquainted with you in ways different from courses, grades, test scores, and other objective data. It will demonstrate your ability to organize thoughts and express yourself. We are looking for an essay that will help us know you better as a person and as a student. Please write an essay (250–500 words) on a topic of your choice or on one of the options listed below. ***Please indicate your topic by checking the appropriate box below.***

- ☐ 1 Evaluate a significant experience, achievement, risk you have taken, or ethical dilemma you have faced and its impact on you.
- ☐ 2 Discuss some issue of personal, local, national, or international concern and its importance to you.
- ☐ 3 Indicate a person who has had a significant influence on you, and describe that influence.
- ☐ 4 Describe a character in fiction, an historical figure, or a creative work (as in art, music, science, etc.) that has had an influence on you, and explain that influence.
- ☐ 5 A range of academic interests, personal perspectives, and life experiences adds much to the educational mix. Given your personal background, describe an experience that illuminates what you would bring to the diversity in a college community, or an encounter that demonstrated the importance of diversity to you.
- ☐ 6 Topic of your choice.

☞ **Attach your essay on a separate sheet(s) (same size please). You must put your full name, date of birth, and name of secondary school on each sheet.**

APPLICATION FEE PAYMENT ☐ Check/money order attached ☐ Counselor-approved Fee Waiver attached

REQUIRED SIGNATURE Your signature is required whether you are an ED, EA, EASC, or regular decision candidate. ***I certify that all information in my application, including my Personal Essay, is my own work, factually true, and honestly presented.***

Signature ..... Date .....

IF APPLYING VIA EARLY DECISION OR EARLY ACTION (1) Complete the Optional ED/EA/EASC Declaration for your early application *only*. (2) Submit the college's required ED/EA/EASC form, if any. (3) Understand that it is your responsibility to report any changes in your schedule to the colleges to which you are applying.

These colleges are committed to administer all educational policies and activities without discrimination on the basis of race, color, religion, national or ethnic origin, age, handicap, or gender.

I don’t think so.

大　学　で

大学で(1):カリキュラムと学生

アメリカでは

- 学ぶ側中心のカリキュラム＝整合性
- 学生の高い意識
- 厳格な成績＝警告制度
- 対話型の講義
- セメスター制

日本では

- 教える側中心のカリキュラム＝不整合
- 学ぶ動機が低い
- 形式的な成績
- 一方通行の講義
- 歪なセメスター制

大学で(2):教員

- コロキウムの重視(セミナーとの違い)
- 自分の意見の主張
  “I don’t think so.”と一人でも主張できる
- 社交性
- 新しい科目のデザイン
- 教育の工夫

ギャップをどう埋めるか

- 話をさせる
- 自分の意見を主張させる
- 「わかる」ということをわからせる
- 考えさせる教育
- 人材育成プランに沿った整合したカリキュラム
- 本来のセメスター制に

九州大学の取組

九州大学学部教育プログラム

2006年4月実施

総合性・学際性

人間性・社会性・国際性

専門性

3．コアセミナーは，高校とは異なる大学における学習への適応を促進し学習意欲を向上させること，及び「読む，書く，調べる，発表する，討論する」等の学問を進めていく上での基礎的な能力を育成することを目標とする。

総合科目

少人数セミナー

語学

健康スポーツ

教養教育

選択履修

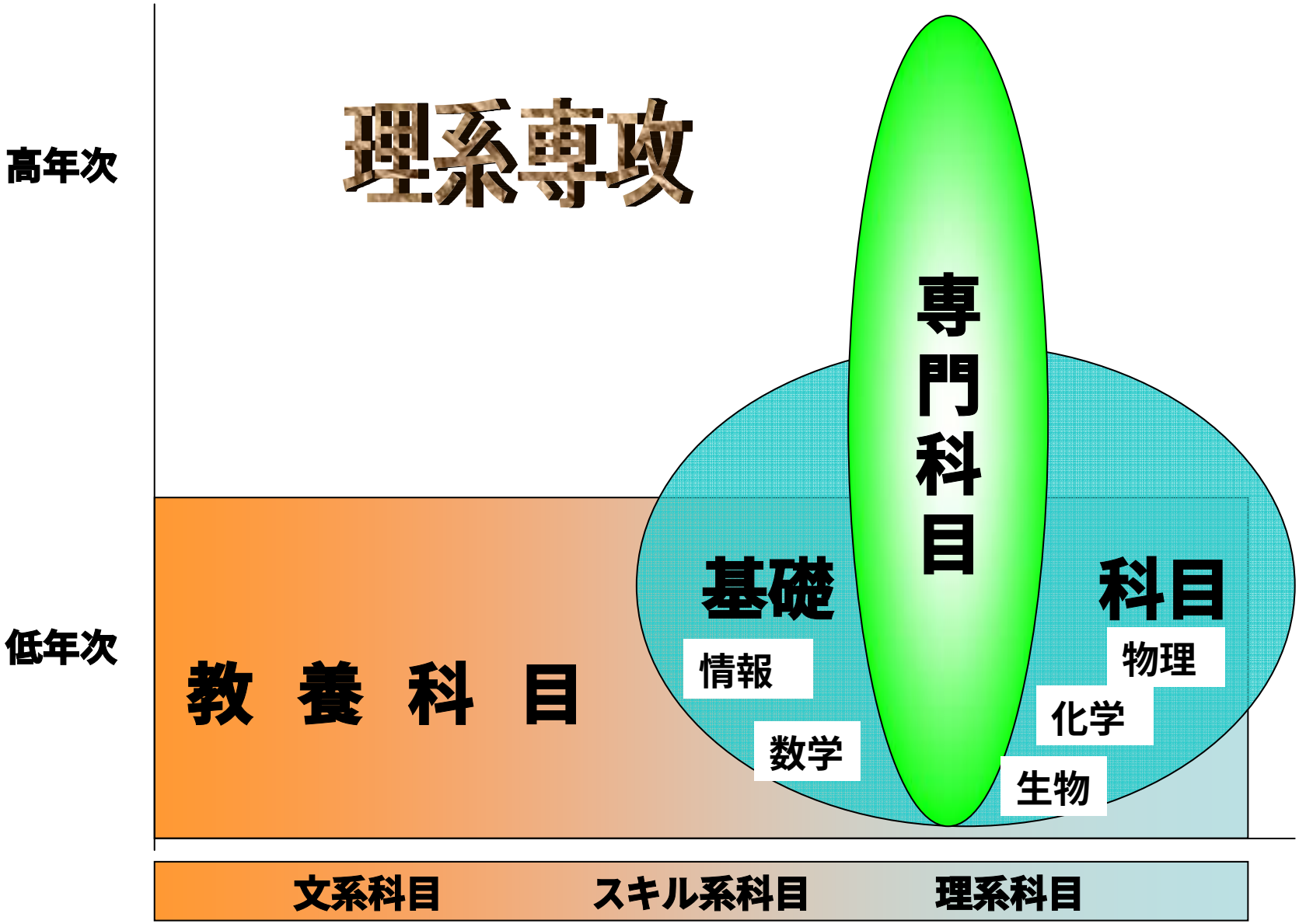
強固な基礎学力

文系基礎

情報処理

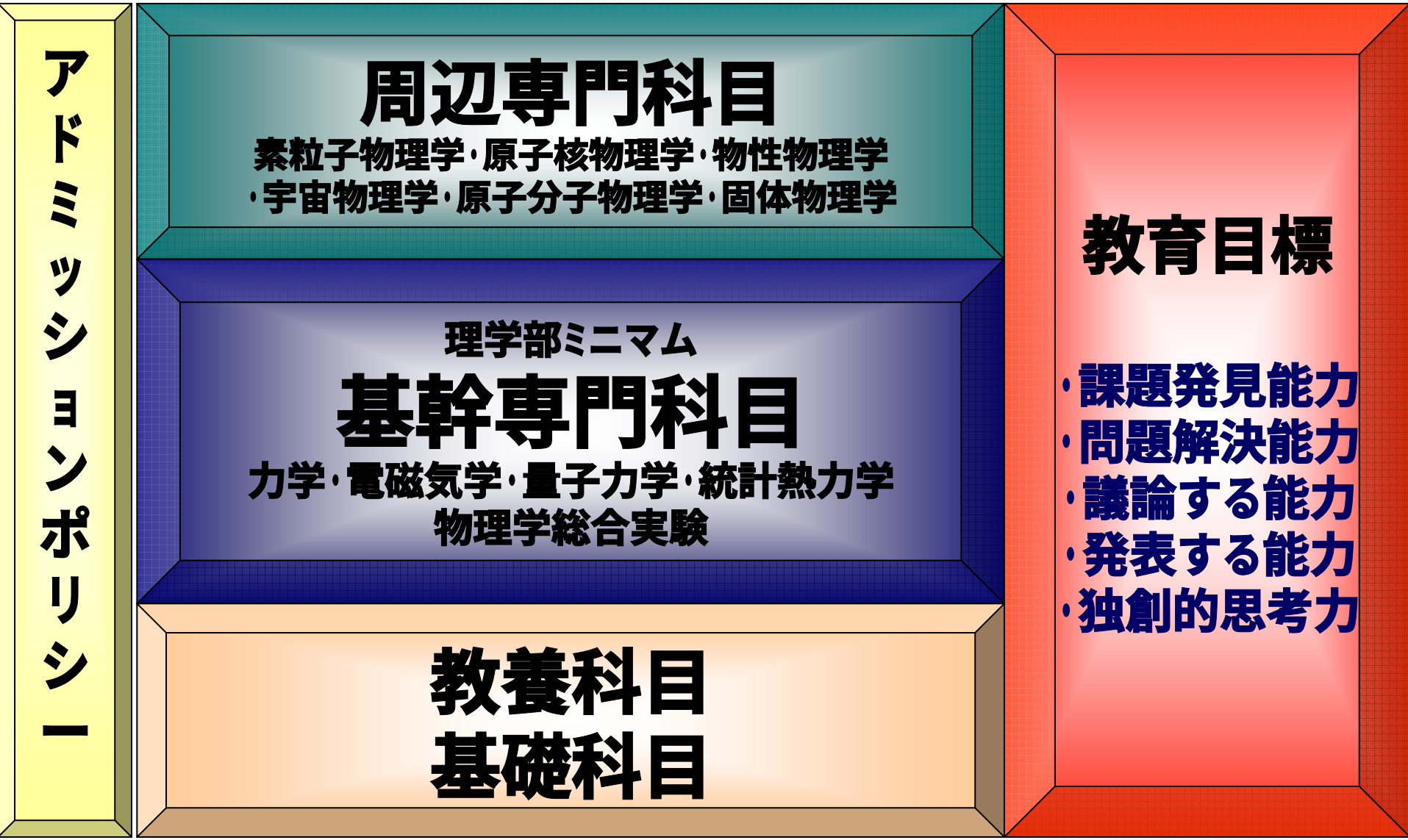
理系基礎

基 礎 教 育


高年次
理系専攻
専門科目
基礎科目
情報
数学
物理
化学
生物
低年次
教養科目
文系科目
スキル系科目
理系科目

理学部専攻教育プラン

[物理学科の例]



成功のためには

- 教員が自己主張できるか
- 教員が「わかる」ということをわかっているか
- カリキュラムに対するコンセンサスがあるか
- 本来のセメスター制の意味の理解